# TAHQUITZ CREEK

## *Levee ID 16 Provisionally Accredited Levee Analysis*

**Prepared for:**

**CITY OF PALM SPRINGS, CALIFORNIA**
**3200 EAST TAHQUITZ CANYON WAY**
**PALM SPRINGS, CA 92263-2743**

**Prepared By:**

**NOLTE ASSOCIATES, INC.**
**15070 AVENUE OF SCIENCE, SUITE 100**
**SAN DIEGO, CA 92128**

**AUGUST 2009**

# TABLE OF CONTENTS

APPENDICES

# EXECUTIVE SUMMARY

This report provides a summary of site investigations, research, and recommendations in regards to the Provisionally Accredited Levee (PAL) Agreement written by the Federal Emergency Management Agency (FEMA) to the City of Palm Springs (City). This PAL Agreement includes Levee ID Number 16 for Tahquitz Creek. The City retained Nolte Associates, Inc. (Nolte) to perform analyses to determine if the Tahquitz Creek Levee meets the minimum requirements established in the Title 44, Chapter 1 of the Code of Federal Regulations, Section 65.10 (Section 65.10). Refer to Appendix A for Section 65.10.

# 1.0 INTRODUCTION

## *1.1 Background*

FEMA is currently undertaking Map Modernization to transform the format of the nation's existing flood hazard mapping inventory from a paper based product to a digital product. In conjunction with this effort FEMA is also striving to improve the quality of flood hazard information. One specific focus for FEMA are areas shown to be protected by levees on effective Flood Insurance Rate Maps (FIRMs). In the process of developing new digital FIRMs (DFIRMs), FEMA is requesting that communities provide evidence to demonstrate that levees meet the minimum requirements established in Section 65.10. Areas shown on effective FIRMs as protected from flooding by levees for which the required information is not provided will be remapped and designated as special flood hazard areas (SFHA). Significant impacts will result from instances in which areas behind levees that are shown to be protected on the effective FIRMs are revised to be designated as SFHA. If these areas are designated as SFHA there will be new limitations for construction and requirements for flood insurance.

Tahquitz Creek is located in Palm Springs, California approximately 0.7 miles south of East Ramon Road and 0.7 miles north of East Palm Canyon Drive (see Figure 1 Site Map). The levee is located on the north side of Tahquitz Creek and provides protection for Demuth Park and a wastewater treatment plant, both owned by the City. The downstream end of the levee begins at the Gene Autry Bridge crossing (Highway 111) and the levee terminates approximately 0.75 miles upstream from Highway 111, adjacent to Demuth Park. Levee ID 16 is located on FIRM Panels 06065C1567G and 06065C1586G. Behind levee mapping on the Effective FIRMs (for Demuth Park and the wastewater treatment plant) is a shaded Zone X. Shaded Zone X is defined as areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than one foot or with drainage areas less than one square miles; and areas protected by levees from 1% annual chance flood.

The concrete lined levee was originally constructed in approximately 1984. In 1994 the Tahquitz Creek Golf Course was constructed within Tahquitz Creek and built on top of the existing levee structure. Construction of the golf course raised the elevation of the channel and the golf course was built on top of the levee's concrete lining. The top of the levee is a concrete golf cart path

and the channel side slopes are part of the golf course. Tahquitz Creek discharges to the southeast where it confluences with Palm Canyon Wash, approximately 800 feet upstream from Highway 111.

## *1.2 Scope*

The City contracted Nolte to perform analyses to determine if Levee ID 16 meets the minimum requirements established in Section 65.10 for the PAL agreement. Tasks performed for this study included data collection, site visit, hydraulic evaluation of Tahquitz Creek including, freeboard analysis, closure evaluation, and interior drainage evaluation. This study summarizes the results of the analyses conducted in conjunction with Section 65.10.

## Figure 1: Site Map


Source: www.maps.google.com

## 2.0 DATA COLLECTION

Several documents were provided to Nolte by the City and by Riverside County Flood Control and Water Conservation District (District) for the analyses. Data provided by the City are as follows:

Topographic Map

- 1995 New Golf Course As-Built Topo

Drainage Studies

- Application/Certification Forms to Obtain a CLOMR for the City of Palm Springs Municipal Golf Course Project Tahquitz Creek (John M. Tettemer & Associates 2/98)
- Bogie Road Hydrology Report 9/27/79

Levee As-Built Plans

- Palm Springs Golf Course North Levee Plan & Profile, 8/3/1993
- Bogie Road Levee Construction As-Built Plans (S&T Western, Inc. 3/21/81 – Certified As-Built on 5/4/84)

HEC-2 Analysis

- Palm Canyon Wash & Tahquitz Creek HEC-2 Cross Sections
- Bogie Road Palm Canyon Wash (Excavated) HEC-2 output

Improvement Plans

- Line 22 Storm Drain Improvements - Phase II Final Storm Drain Report (DMC Design Group 7/18/08)

Hydraulic Analysis

- Hydraulic Analysis of the Proposed Expansion of the City of Palm Springs Municipal Golf Course (John M. Tettemer & Associates 9/18/91)
- Palm Canyon Wash Hydraulic Analysis (Simons & Associates, Inc 2/97)

Geotechnical Reports

- Data Review & Levee Evaluation Palm Canyon Wash at Bogie Road North (left) Bank Levee (Joe Sciandrone 3/13/81)

- Bogie Road Bridge Project North Levee, Palm Springs, CA (Leighton & Associates 9/21/81)
- Geotechnical/Geological Investigation South Levee, Palm Canyon Wash (CHJ Incorporated 8/29/1993)
- Limited Geotechnical Investigation Proposed Palm Canyon Wash Floodwalls (CHJ Incorporated 6/21/05)

Operation and Maintenance Plans

- Tahquitz Creek & Palm Canyon Channel - Vicinity of the Tahquitz Canyon Golf Course within The City of Palm Springs Maintenance Plan (John M. Tettemer & Associates Nov 1999)

Operation and Maintenance Inspection Records

- Concrete Cylinder Compression Test Report on Bogie Road Bridge (11/10/81 Leighton & Associates)
- Bogie Road Bridge - North Channel Lining Coring (Leighton & Assoc. 4/15/83)

Miscellaneous

- Aerial Photograph of a portion of City of Palm Springs (showing the concrete lined Tahquitz Creek Levee) in 1983
- 1989 Aerial Photograph of wastewater treatment plant
- Palm Springs Golf Course Mechanical, Electrical & Communication Cable Plans (Gordons Irrigation Consulting 6/4/93)
- City of Palm Springs Plans for Construction of Palm Springs Golf Course Tahquitz Erosion Protection As-Built (John M. Tettemer & Associates 4/5/94)
- Palm Canyon Wash Floodwall North & South Levees (John M. Tettemer & Associates 4/12/93)
- Palm Springs Golf Course Gene Autry Trail & Tahquitz Creek Construction Drawings (Theodore G. Robinson Golf Course Architect 4/12/93)
- Palm Canyon Wash Floodwall Design Project (John M. Tettemer & Associates November 2004)

Data provided by the District are as follows:

Topographic Data

- Palm Canyon Wash topographic data, obtained from Riverside County Flood Control and Water Conservation. The topographic data was created in 2007 at 1-foot contour intervals.

- Tahquitz Creek topographic data, obtained from Riverside County Flood Control and Water Conservation. The topographic data has 4-foot contour intervals and the date when the data was created is unknown.

In addition to these documents, Nolte was provided with numerous correspondence letters and files from the City which provide historic information of the Tahquitz Creek levee.

## 3.0 SITE VISIT

A site visit was conducted December 30, 2008 with engineers and geologists from Nolte, AMEC Geomatrix, Inc. and GeoTek, Inc. Levee ID 16 was walked and observations about the existing conditions of the levee were documented. Photographs were taken to document these conditions and can be used to help the City assess the type of maintenance that can be completed. Site photographs are located in Appendix B.

The field inspection began at the upstream end of the levee, referred to as station 0+00, and continued downstream to the end of the levee at the Highway 111 crossing, station 40+90 (see Appendix B for stationing). The typical cross section on the May 4, 1984 levee as-built plans, by S&T Western, Inc. Consulting Engineers, illustrates the concrete lined channel slope as 1.5:1 (horizontal to vertical). It is apparent that construction of the Tahquitz Creek Golf Course in 1994 has significantly changed the Tahquitz Creek levee and the topography of the channel since the levee was built in the 1980s. The golf course was constructed over the levee's concrete lining and the golf course adjacent to the levee (within Tahquitz Creek) is equal to or higher in elevation than the top of levee at some locations. The golf course has numerous rolling hills within the channel which are often higher than the top of levee. The change of the channel's topography due to the Tahquitz Creek Golf Course could reduce conveyance within the channel and presents a concern as to how this will impact freeboard.

The levee appeared to be well maintained with minimal animal burrows and erosion. Erosion observed was located adjacent to the levee along portions of the golf course where landscaping lacked ground cover. The levee's concrete lining was slightly exposed at several locations near the top of levee, which is an asphalt walkway.

An important aspect of the geotechnical and hydraulic analyses is having accurate contour data to use in the analyses. Previous research done by Nolte found that the Riverside County Flood Control and Water Conservation District does not have 2-foot contour data for the levee reach. The District has 4-foot contour data mixed with some 1-foot contour data for which the Nolte

Team used. The Nolte Team also had the top and toe of the levee surveyed to provide more accurate data for use in the geotechnical and hydraulic calculations.

# 4.0 HYDRAULIC EVALUATION

## *4.1 Freeboard Evaluation*

This section describes the hydraulic model prepared by Nolte to determine if the levee meets freeboard requirements of Section 65.10. Additionally, Nolte's freeboard evaluation was compared to a previous evaluation prepared by John M. Tettemer & Associates, Ltd. (Tettemer) in February 1998 for a Conditional Letter of Map Revision (CLOMR) for the construction of the Tahquitz Creek Golf Course.

A hydraulic model for Tahquitz Creek was prepared using HEC-RAS version 4.0 to determine the freeboard of the levee structure. Cross sections were placed approximately every 250 to 350 feet and begin approximately 550 feet upstream from the upstream end of the Tahquitz Creek levee, downstream to the Highway 111 crossing. Refer to Appendix C for the HEC-RAS Workmap, showing locations for cross sections, and for the HEC-RAS output. A Manning's Roughness Coefficient of 0.030 was used in the hydraulic analysis. This value was chosen to match the Manning's Roughness Coefficient used in Tettemer's CLOMR, and it is a reasonable value to use for the grass lined golf course. Nolte used Palm Canyon Wash topographic data and Tahquitz Creek topographic data, both obtained from the District to create the hydraulic model. The Palm Canyon Wash topographic data was created in 2007 at 1-foot contour intervals and the Tahquitz Creek topographic data was created at 4-foot contour intervals. The date that the Tahquitz Creek topographic data was created is unknown. In addition to the topographic data provided by the District, Nolte surveyed the top and toe of levee elevations and incorporated these elevations into the topographic data used for the hydraulic analysis. Both topographic data files and Nolte's survey data have a horizontal datum of NAD83 and a vertical datum of NAVD88.

Nolte used the effective hydrologic and hydraulic data from FEMA's library for the freeboard evaluation. The 100-year peak discharge, from the effective FEMA model, for Tahquitz Creek and the confluence of Tahquitz Creek and Palm Canyon Wash is 8,000 cubic-feet-per-second (cfs) and 25,200 cfs, respectively. Nolte's hydraulic model determined that several segments of the Tahquitz Creek levee system did not meet the freeboard requirement stated in Section 65.10, which states that there must be at least three feet of freeboard above the water surface elevation (WSEL) of the 100-year flood (base flood). For areas within 100 feet of structures, such as bridges, there must be at least four feet of freeboard.

Nolte compared the calculated water surface elevations (WSELs) from the hydraulic model to the effective Flood Insurance Study's (FIS) base flood WSELs (adjusted to NAVD88 datum); concluding that Nolte's WSELs were significantly higher than the FIS WSELs. This is most likely attributed to the construction of the Tahquitz Creek golf course. A Conditional Letter of Map Revision (CLOMR) for the construction of the Tahquitz Creek Golf Course was prepared by John M. Tettemer & Associates, Ltd. (Tettemer) in February 1998, but a LOMR for the

Tahquitz Creek Golf Course was never approved. It is assumed that the FIS WSELs of Tahquitz Creek are prior to the construction of the golf course. Nolte evaluated the WSELs associated with the As-Built Condition Model Natural Flood Hazard Analysis (post golf course construction) prepared by Tettemer for the 1998 CLOMR. Nolte's cross sections that did not meet the freeboard requirements of Section 65.10 matched the locations that also lacked sufficient freeboard in Tettemer's CLOMR analysis.

The following cross sections, which can be seen on the HEC-RAS Workmap in Appendix C, do not meet the requirements of Section 65.10:

- Cross Sections 130 through 160, adjacent to the Wastewater Treatment Plant.

If freeboard deficiencies are not corrected, the Special Flood Hazard Area (SFHA), Zone AE, will be revised to reflect the possible flooding that might occur if the levee fails or flood waters overtop. If the SFHA is revised, the new limits could include areas in a Zone A, resulting in the requirement to purchase flood insurance as part of the National Flood Insurance Program. Table 1 summarizes Nolte's HEC-RAS cross sections, WSELs, and freeboard. Cross sections that lack sufficient freeboard required by Section 65.10 are highlighted.

**Table 1: Nolte HEC-RAS Cross Sections Summary**

| Approx. FEMA Cross Section | NGVD29 CWSEL (ft) | [1]NAVD88 CWSEL (ft) | [2]Nolte HEC-RAS Cross Section | Existing Top of Levee (ft) | [2]Nolte WSEL (ft) | Freeboard (ft) |
|---|---|---|---|---|---|---|
| | | | | | n=0.03 | |
| (B) | 372.4 | 375.1 | 250 | N/A | 374.4 | N/A |
| | | | 240 | N/A | 371.1 | N/A |
| | | | [3] 230 | 376.0 | 369.9 | 6.09 |
| | | | 220 | 374.9 | 369.3 | 5.60 |
| | | | 210 | 373.4 | 369.3 | 4.07 |
| (A) | 365.3 | 368.0 | N/A | N/A | N/A | N/A |
| | | | 200 | 372.2 | 369.0 | 3.18 |
| | | | 190 | 372.0 | 366.7 | 5.33 |
| | | | 180 | 370.5 | 365.5 | 4.98 |
| | | | 170 | 369.3 | 363.8 | 5.43 |
| | | | 160 | 365.9 | 362.9 | 2.97 |
| | | | 150 | 364.7 | 361.7 | 2.97 |
| | | | 140 | 363.7 | 361.2 | 2.52 |
| (G) | 356.1 | 358.8 | N/A | N/A | N/A | N/A |
| | | | 130 | 362.3 | 360.7 | 1.58 |
| | | | [4] 120 | 361.0 | 357.3 | 3.70 |
| | | | 110 | 360.0 | 356.6 | 3.43 |
| | | | 100 | 363.0 | 355.3 | 7.72 |

**[1]NAVD88=NGVD29 + 2.7 ft**

**[2] Nolte water surface elevations have a vertical datum of NAVD88.**

**[3] Begin Tahquitz Creek Levee**

**[4] Confluence of Tahquitz Creek with Palm Canyon Wash**

Table 2 summarizes the cross sections, WSELs, and freeboard for the As-Built Condition Model Natural Flood Hazard Analysis prepared by Tettemer for the 1998 CLOMR. Cross sections that lack adequate freeboard required by Section 65.10 are highlighted.

**Table 2: Tettemer 1998 CLOMR Cross Sections Summary**

| [1]CLOMR Cross Section | CLOMR NGVD29 Effective Model Top of Levee (ft) | [2]NAVD88 Effective Model Top of Levee (ft) | CLOMR NGVD29 WSEL (ft) | [2]CLOMR NAVD88 WSEL (ft) | Freeboard (ft) | Approx. Nolte Cross Section |
|---|---|---|---|---|---|---|
| 62.8 | N/A | N/A | 376.52 | 379.22 | N/A | |
| 61.95 | N/A | N/A | 373.06 | 375.76 | N/A | |
| 61.15 | N/A | N/A | 373.35 | 376.05 | N/A | |
| 60.45 | N/A | N/A | 373.41 | 376.11 | N/A | |
| 58.55 | N/A | N/A | 372.81 | 375.51 | N/A | |
| 56.9 | N/A | N/A | 372.63 | 375.33 | N/A | |
| 55 | N/A | N/A | 371.68 | 374.38 | N/A | |
| 52.65 | N/A | N/A | 370.62 | 373.32 | N/A | |
| 51.4 | N/A | N/A | 369.88 | 372.58 | N/A | |
| 50.2 | N/A | N/A | 369.50 | 372.20 | N/A | |
| 48.05 | 373.00 | 375.70 | 369.19 | 371.89 | 3.81 | |
| 45.8 | 372.00 | 374.70 | 367.93 | 370.63 | 4.07 | 220 |
| 44.6 | 371.00 | 373.70 | 367.71 | 370.41 | 3.29 | |
| 43.5 | 371.00 | 373.70 | 367.61 | 370.31 | 3.39 | |
| 42.2 | 372.00 | 374.70 | 366.76 | 369.46 | 5.24 | 210 |
| 41.5 | 370.00 | 372.70 | 366.07 | 368.77 | 3.93 | |
| 40.8 | 370.00 | 372.70 | 365.87 | 368.57 | 4.13 | |
| 39.55 | 369.00 | 371.70 | 365.47 | 368.17 | 3.53 | 200 |
| 37.2 | 369.00 | 371.70 | 365.30 | 368.00 | 3.70 | |
| 35.75 | 368.00 | 370.70 | 363.47 | 366.17 | 4.53 | |
| 34.8 | 368.00 | 370.70 | 363.39 | 366.09 | 4.61 | |
| 32.85 | 368.00 | 370.70 | 363.30 | 366.00 | 4.70 | |
| 30.95 | 368.00 | 370.70 | 362.60 | 365.30 | 5.40 | |
| 28.45 | 365.60 | 368.30 | 362.26 | 364.96 | 3.34 | |
| 26.5 | 365.00 | 367.70 | 361.19 | 363.89 | 3.81 | |
| 24.15 | 362.00 | 364.70 | 358.96 | 361.66 | 3.04 | |
| 22.75 | 361.00 | 363.70 | 358.87 | 361.57 | 2.13 | |
| 21.7 | 361.00 | 363.70 | 358.98 | 361.68 | 2.02 | |
| 19.5 | 361.50 | 364.20 | 359.08 | 361.78 | 2.42 | |
| 17.5 | 360.00 | 362.70 | 358.71 | 361.41 | 1.29 | |
| 15.5 | 358.90 | 361.60 | 358.12 | 360.82 | 0.78 | |
| 14.65 | 358.00 | 360.70 | 355.93 | 358.63 | 2.07 | 120 |

**[1]CLOMR by John M. Tettemer & Associates, Ltd. February 1998, As-Built Condition Model Natural Flood Hazard Analysis**

**[2]NAVD88 = NGVD29 + 2.7 ft**

Table 2 shows that several cross sections from the CLOMR prepared by Tettemer lacked sufficient freeboard at the time of the CLOMR was prepared. While the computed water surface elevations from Nolte's hydraulic model are different than the CLOMR hydraulic model, the locations of insufficient freeboard are consistent. In addition, some minor discrepancies were found between the top of levee elevations surveyed by Nolte and the top of levee elevations used in Tettemer's CLOMR. These discrepancies do not have a significant impact on the results of the overall freeboard evaluation.

### *4.2 Closures Evaluation*

The site visit, conducted December 30, 2008, concluded the Tahquitz Creek levee does not contain any closure devices; therefore, a closure analysis for Tahquitz Creek is not applicable.

### *4.3 Interior Drainage Evaluation*

During the December site visit the Nolte Team observed a saturated low point on the landside of the levee at the Demuth Park soccer field. This low point is on the landside of the levee near the soccer field, adjacent to the Tahquitz Creek levee. This saturation could have been the result of a rain event that occurred prior to the site visit or to possible over watering of Demuth Park. After reviewing the Tahquitz Creek topographic data that was provided by the District, Nolte concluded ponding could occur at the soccer field after storm events because there are not any existing drainage facilities at this low point to alleviate ponding water.

The Riverside County Synthetic Unit Hydrograph Method was used to determine the storm runoff volume of the 100-year, 1-, 3-, 6-, and 24-hour storm events that are tributary to the low point at the soccer field. The tributary area used in the unit hydrograph calculations is 37.9 acres, which consists of most of Demuth Park. CivilCadd/CivilDesign, developed by Joseph E. Bonadiman and Associates Inc., was used to calculate unit hydrographs. The 100-year, 24-hour unit hydrograph generated the largest runoff volume of 3.6 acre-feet. This unit hydrograph was input into Bentley Haestad PondPack to calculate the maximum ponded WSEL at the Demuth Park soccer field. Assuming an average infiltration rate of 0.76 inches per hour for the soccer field (per Plate E-6.2 of the Riverside County Flood Control and Water Conservation District Hydrology Manual) the soccer field will pond to an approximate WSEL of 361.7 feet during a 100-year 24-hour storm event. According to Nolte's survey points, the toe of the Tahquitz Creek levee at the southeast end of the soccer field (which is the lowest elevation of the toe of levee adjacent to the soccer field) is at an elevation of approximately 358.5 feet; therefore the ponding of the soccer field during a 100-year 24-hour storm event is approximately 3 feet higher than the toe of the levee.

The topographic data provided by the District that was used for the unit hydrograph calculations has four-foot contour intervals. More accurate topographic data, one or two-foot contour intervals, could alter the computed WSEL of the Demuth Park soccer field.

The hydrograph data generated by Nolte was given to AMEC Geomatrix to perform a stability and seepage analysis for the landside of the levee at this location. The analysis consisted of a transient state analysis using complex computer modeling software. AMEC Geomatrix's analysis concluded that the effect of ponded water from the hydrograph generated was minimal on the levee stability. Therefore, runoff draining to the landside of the levee will not cause significant levee instability. This levee has met the interior drainage requirements for certification under Section 65.10.

# 5.0 Levee Freeboard Deficiency Recommendations

Nolte identified and evaluated three options as possible solutions to correct the freeboard deficiencies of Tahquitz Creek so the levee can meet the freeboard requirements for certification under Section 65.10. These options include grading a portion of Palm Canyon Wash, beginning upstream of the confluence with Tahquitz Creek and continuing downstream nearly to Highway 111; grading within Tahquitz Creek; and raising the elevation of a portion of the Tahquitz Creek levee. Each option is an independent solution to correct freeboard deficiencies. Anticipated approximate limits of grading for each option are depicted on the Freeboard Deficiency Recommendation Exhibit in Appendix D. Additionally, a summary of proposed WSELs and freeboard for each option are included in Appendix D.

## *5.1 Option 1: Lower Elevation of Palm Canyon Wash*

The confluence of Tahquitz Creek with Palm Canyon Wash occurs at Cross Section 120 of Nolte's hydraulic model. The first solution evaluated to remediate Tahquitz Creek freeboard deficiencies was to lower the elevation of Palm Canyon Wash from approximately 75 feet upstream of Cross Section 130 to approximately 120 feet upstream of Cross Section 100. Grading Palm Canyon Wash to have a lower elevation at these cross sections will increase the conveyance and reduce backwater effects on Tahquitz Creek, providing adequate freeboard for Tahquitz Creek to meet the requirements of Section 65.10. The area of Palm Canyon Wash proposed to be graded are illustrated in a magenta boundary on existing Cross Sections 110, 120, and 130 of the Freeboard Deficiency Recommendation in Appendix D.

Nolte was contracted by the District to assist them with research and analysis required for the PAL agreement for the levees of Palm Canyon Wash. Nolte prepared a hydraulic model (using HEC-RAS) of Palm Canyon Wash for the Palm Canyon Wash PAL agreement analysis. The proposed grading for this option effects the geometry of Cross Sections 190 and 200 of the Palm Canyon Wash hydraulic model. The proposed grading within Palm Canyon Wash that could remediate Tahquitz Creek freeboard deficiencies was evaluated in the Palm Canyon Wash hydraulic model to determine possible affects the grading could have on freeboard of the Palm Canyon Wash levee and velocities within Palm Canyon Wash. Cross Sections 190 and 200 of the Palm Canyon Wash hydraulic model were modified to include proposed grading within Palm Canyon Wash.

Appendix E has a spreadsheet, titled "Palm Canyon Wash Option 1: Grade Palm Canyon Wash Near Confluence With Tahquitz Creek." This spreadsheet compares existing Palm Canyon Wash levee analysis prepared for the District's PAL analysis to the freeboard due to proposed grading within Palm Canyon Wash to create freeboard for Tahquitz Creek. The proposed grading of Palm Canyon Wash only altered freeboard at Cross Section 200 of the Palm Canyon Wash hydraulic model, which increased from 4.13 feet to 4.49 feet. The proposed grading resulted in a decrease of velocities at Cross Sections 190 and 200 (of Palm Canyon Wash hydraulic model). Any affects to Palm Canyon Wash are highlighted in yellow on the spreadsheet in Appendix E. Additionally, Appendix E contains cross sections with hatching to depict the area of Palm Canyon Wash that is to be removed by proposed grading.

From this preliminary analysis of proposed grading within Palm Canyon Wash, it appears to be a viable option to solve freeboard deficiencies of Tahquitz Creek. Although the proposed grading does not appear to negatively impact Palm Canyon Wash, it is recommended that a more detailed analysis of proposed changes of Palm Canyon Wash be evaluated. The analysis may require an environmental impact study to determine the viability for this option. Nolte's previous hydraulic model of Palm Canyon Wash only contains two cross sections within the anticipated limits of grading. A more detailed analysis with more cross sections located within the anticipated limits of grading is recommended. Additionally, should this option be pursued in the future, permission will need to be granted from the District as Palm Canyon Wash is in their jurisdiction.

### *5.2 Option 2: Grading Within Tahquitz Creek*

The second option Nolte assessed to remediate Tahquitz Creek freeboard deficiencies is to propose grading within Tahquitz Creek. It is apparent that the several locations of the Tahquitz Creek Golf Course were constructed on fill, which reduced conveyance within Tahquitz Creek and is attributing to the levee not meeting the freeboard requirements of Section 65.10. Removing some of these high points (fill) at Cross Sections 120, 130, and 150 should resolve freeboard deficiencies. The high points that are proposed to be removed are illustrated in a blue boundary on existing Cross Sections 120, 130, and 150 of the Freeboard Deficiency Recommendation Exhibit in Appendix D. Cross sections showing these high points in the golf course that are proposed to be removed are located in Appendix F.

### *5.3 Option 3: Raise Elevation of Tahquitz Creek Levee*

Lastly, the third option Nolte evaluated to remediate Tahquitz Creek freeboard deficiencies was raising the elevation of the Tahquitz Creek levee by 0.5 feet to 2.0 feet for Cross Sections 130 through 160 (see Appendix D). Proposed Cross Sections 130 through 160 are included in Appendix G. Increasing the elevation of the levee at these cross sections will create grading within Tahquitz Creek that encroaches on the golf course, as can be seen on the Freeboard Deficiency Recommendation Exhibit. For proposed Cross Section's 130 through 160, similar slopes of the levee (landside and channel side) were maintained for each respective cross section to preserve appearance of the golf course, which has gradual and rolling slopes. The levee slope (channel side) at several cross sections is particularly flat, at approximately 4 to 20 percent. The

proposed cross sections maintain the existing levee slope, which causes a more significant encroachment on the golf course than if a steeper channel side levee slope was used. If the levee slope (channel side) was graded to 50 percent, the limits of grading encroaching the golf course could be reduced. The location where the elevation of the levee needs to be raised is shown in a green boundary on existing Cross Sections 120, 130, and 150 on the Freeboard Deficiency Recommendation Exhibit.

## 6.0 OPERATIONS AND MAINTENANCE PLAN

Section 65.10 states that in order for a levee to be recognized as providing protection from the base flood, levee systems must be maintained in accordance with an officially adopted maintenance plan. A copy of the plan must be submitted to FEMA by the owner of the levee system. The plan must state formal procedures that ensure the stability, height, and integrity of the levee. It should also state the frequency that maintenance on the levee should be preformed and the person responsible for the performance of the levee. The City of Palm Springs has an existing Maintenance Plan for Tahquitz Creek that was prepared by Tettemer in November 1999. Nolte feels the existing Operation and Maintenance Plan did not provide adequate maintenance detail; therefore, Nolte has created a new Operation and Maintenance Plan for the City of Palm Springs.

## 7.0 CONCLUSION

These analyses were prepared for Levee ID 16 for Tahquitz Creek in conjunction with Section 65.10. After evaluating freeboard, closures, interior drainage, and freeboard deficiency recommendations, the following conclusions were reached:

- The levee appeared to be well maintained with minimal animal burrows and erosion.
- Levee ID 16 does not meet freeboard requirements for certification under Section 65.10.
- Levee ID 16 does not contain closure devices; therefore, a closure analysis is not applicable.
- Levee ID 16 meets the interior drainage requirements for certification under Section 65.10.
- There are several feasible options to fix freeboard deficiencies; several preliminary options were presented in this report.
- Levee ID 16 has a Operations and Maintenance Plan that Nolte revised to bring into compliance with Section 65.10.
- Levee ID 16 does not meet some of the requirements for certification under Section 65.10.

# 8.0 REFERENCES

Bentley Systems, Inc., *PondPack,* © 2005, Version 10.0

City of Palm Springs, California, Riverside County, *Flood Insurance Study*, July 7, 1999

CivilCadd/CivilDeisgn Engineering Software by Joseph E. Bondamin & Associates, Inc., *Unit Hydrograph System Model*, ©1989-2002, Version 6.1

John M. Tettemer & Associates, Ltd., *Application/Certification Forms to Obtain a Conditional Letter of Map Revision for the City of Palm Springs Municipal Golf Course Expansion Project Tahquitz Creek*, February 1998

Riverside County Flood Control & Water Conservation District, *Hydrology Manual,* April 1978

Riverside County Flood Control & Water Conservation District, *Palm Canyon Wash 1-foot Topographic Data,* 2007

Riverside County Flood Control & Water Conservation District, *Tahquitz Creek 4-foot Topographic Data,* Date Unknown

S&T Western, Inc. Consulting Engineers, *As-Built Gene Autry Trail Bridge Alt. 3 Levee Construction*, May 4, 1984

U.S. Army Corps of Engineers Hydrologic Engineering Center, *HEC-RAS*, Version 4.0.0, March 2008

# APPENDIX A

TITLE 44 OF THE CODE OF FEDERAL REGULATIONS, SECTION 65.10

**Title 44 of the Code of Federal Regulations (CFR), Section 65.10**
**(44 CFR 65.10)**

water surface profile of the original hydraulic computer model. The alternate model must be then modified to include all encroachments that have occurred since the existing floodway was developed.

(ii) The floodway analysis must be performed with the modified computer model using the desired floodway limits.

(iii) The floodway limits must be set so that combined effects of the past encroachments and the new floodway limits do not increase the effective base flood elevations by more than the amount specified in § 60.3(d)(2). Copies of the input and output data from the original and modified computer models must be submitted.

(3) Delineation of the revised floodway on a copy of the effective NFIP map and a suitable topographic map.

(d) *Certification requirements.* All analyses submitted shall be certified by a registered professional engineer. All topographic data shall be certified by a registered professional engineer or licensed land surveyor. Certifications are subject to the definition given at § 65.2 of this subchapter.

(e) *Submission procedures.* All requests that involve changes to floodways shall be submitted to the appropriate FEMA Regional Office servicing the community's geographic area.

[51 FR 30315, Aug. 25, 1986]

### § 65.8 Review of proposed projects.

A community, or an individual through the community, may request FEMA's comments on whether a proposed project, if built as proposed, would justify a map revision. FEMA's comments will be issued in the form of a letter, termed a Conditional Letter of Map Revision, in accordance with 44 CFR part 72. The data required to support such requests are the same as those required for final revisions under §§ 65.5, 65.6, and 65.7, except as-built certification is not required. All such requests shall be submitted to the FEMA Headquarters Office in Washington, DC, and shall be accompanied by the appropriate payment, in accordance with 44 CFR part 72.

[62 FR 5736, Feb. 6, 1997]

### § 65.9 Review and response by the Administrator.

If any questions or problems arise during review, FEMA will consult the Chief Executive Officer of the community (CEO), the community official designated by the CEO, and/or the requester for resolution. Upon receipt of a revision request, the Administrator shall mail an acknowledgment of receipt of such request to the CEO. Within 90 days of receiving the request with all necessary information, the Administrator shall notify the CEO of one or more of the following:

(a) The effective map(s) shall not be modified;

(b) The base flood elevations on the effective FIRM shall be modified and new base flood elevations shall be established under the provisions of part 67 of this subchapter;

(c) The changes requested are approved and the map(s) amended by Letter of Map Revision (LOMR);

(d) The changes requested are approved and a revised map(s) will be printed and distributed;

(e) The changes requested are not of such a significant nature as to warrant a reissuance or revision of the flood insurance study or maps and will be deferred until such time as a significant change occurs;

(f) An additional 90 days is required to evaluate the scientific or technical data submitted; or

(g) Additional data are required to support the revision request.

(h) The required payment has not been submitted in accordance with 44 CFR part 72, no review will be conducted and no determination will be issued until payment is received.

[51 FR 30315, Aug. 25, 1986; 61 FR 46331, Aug. 30, 1996, as amended at 62 FR 5736, Feb. 6, 1997]

**65.10**

### § 65.10 Mapping of areas protected by levee systems.

(a) *General.* For purposes of the NFIP, FEMA will only recognize in its flood hazard and risk mapping effort those levee systems that meet, and continue to meet, minimum design, operation, and maintenance standards that are consistent with the level of protection sought through the comprehensive

flood plain management criteria established by §60.3 of this subchapter. Accordingly, this section describes the types of information FEMA needs to recognize, on NFIP maps, that a levee system provides protection from the base flood. This information must be supplied to FEMA by the community or other party seeking recognition of such a levee system at the time a flood risk study or restudy is conducted, when a map revision under the provisions of part 65 of this subchapter is sought based on a levee system, and upon request by the Administrator during the review of previously recognized structures. The FEMA review will be for the sole purpose of establishing appropriate risk zone determinations for NFIP maps and shall not constitute a determination by FEMA as to how a structure or system will perform in a flood event.

(b) *Design criteria.* For levees to be recognized by FEMA, evidence that adequate design and operation and maintenance systems are in place to provide reasonable assurance that protection from the base flood exists must be provided. The following requirements must be met:

(1) *Freeboard.* (i) Riverine levees must provide a minimum freeboard of three feet above the water-surface level of the base flood. An additional one foot above the minimum is required within 100 feet in either side of structures (such as bridges) riverward of the levee or wherever the flow is constricted. An additional one-half foot above the minimum at the upstream end of the levee, tapering to not less than the minimum at the downstream end of the levee, is also required.

(ii) Occasionally, exceptions to the minimum riverine freeboard requirement described in paragraph (b)(1)(i) of this section, may be approved. Appropriate engineering analyses demonstrating adequate protection with a lesser freeboard must be submitted to support a request for such an exception. The material presented must evaluate the uncertainty in the estimated base flood elevation profile and include, but not necessarily be limited to an assessment of statistical confidence limits of the 100-year discharge; changes in stage-discharge relationships; and the sources, potential, and magnitude of debris, sediment, and ice accumulation. It must be also shown that the levee will remain structurally stable during the base flood when such additional loading considerations are imposed. Under no circumstances will freeboard of less than two feet be accepted.

(iii) For coastal levees, the freeboard must be established at one foot above the height of the one percent wave or the maximum wave runup (whichever is greater) associated with the 100-year stillwater surge elevation at the site.

(iv) Occasionally, exceptions to the minimum coastal levee freeboard requirement described in paragraph (b)(1)(iii) of this section, may be approved. Appropriate engineering analyses demonstrating adequate protection with a lesser freeboard must be submitted to support a request for such an exception. The material presented must evaluate the uncertainty in the estimated base flood loading conditions. Particular emphasis must be placed on the effects of wave attack and overtopping on the stability of the levee. Under no circumstances, however, will a freeboard of less than two feet above the 100-year stillwater surge elevation be accepted.

(2) *Closures.* All openings must be provided with closure devices that are structural parts of the system during operation and design according to sound engineering practice.

(3) *Embankment protection.* Engineering analyses must be submitted that demonstrate that no appreciable erosion of the levee embankment can be expected during the base flood, as a result of either currents or waves, and that anticipated erosion will not result in failure of the levee embankment or foundation directly or indirectly through reduction of the seepage path and subsequent instability. The factors to be addressed in such analyses include, but are not limited to: Expected flow velocities (especially in constricted areas); expected wind and wave action; ice loading; impact of debris; slope protection techniques; duration of flooding at various stages and velocities; embankment and foundation materials; levee alignment, bends, and transitions; and levee side slopes.

(4) *Embankment and foundation stability.* Engineering analyses that evaluate levee embankment stability must be submitted. The analyses provided shall evaluate expected seepage during loading conditions associated with the base flood and shall demonstrate that seepage into or through the levee foundation and embankment will not jeopardize embankment or foundation stability. An alternative analysis demonstrating that the levee is designed and constructed for stability against loading conditions for Case IV as defined in the U.S. Army Corps of Engineers (COE) manual, ''Design and Construction of Levees'' (EM 1110–2–1913, Chapter 6, Section II), may be used. The factors that shall be addressed in the analyses include: Depth of flooding, duration of flooding, embankment geometry and length of seepage path at critical locations, embankment and foundation materials, embankment compaction, penetrations, other design factors affecting seepage (such as drainage layers), and other design factors affecting embankment and foundation stability (such as berms).

(5) *Settlement.* Engineering analyses must be submitted that assess the potential and magnitude of future losses of freeboard as a result of levee settlement and demonstrate that freeboard will be maintained within the minimum standards set forth in paragraph (b)(1) of this section. This analysis must address embankment loads, compressibility of embankment soils, compressibility of foundation soils, age of the levee system, and construction compaction methods. In addition, detailed settlement analysis using procedures such as those described in the COE manual, ''Soil Mechanics Design—Settlement Analysis'' (EM 1100–2–1904) must be submitted.

(6) *Interior drainage.* An analysis must be submitted that identifies the source(s) of such flooding, the extent of the flooded area, and, if the average depth is greater than one foot, the water-surface elevation(s) of the base flood. This analysis must be based on the joint probability of interior and exterior flooding and the capacity of facilities (such as drainage lines and pumps) for evacuating interior floodwaters.

(7) *Other design criteria.* In unique situations, such as those where the levee system has relatively high vulnerability, FEMA may require that other design criteria and analyses be submitted to show that the levees provide adequate protection. In such situations, sound engineering practice will be the standard on which FEMA will base its determinations. FEMA will also provide the rationale for requiring this additional information.

(c) *Operation plans and criteria.* For a levee system to be recognized, the operational criteria must be as described below. All closure devices or mechanical systems for internal drainage, whether manual or automatic, must be operated in accordance with an officially adopted operation manual, a copy of which must be provided to FEMA by the operator when levee or drainage system recognition is being sought or when the manual for a previously recognized system is revised in any manner. All operations must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP.

(1) *Closures.* Operation plans for closures must include the following:

(i) Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials, that will be used to trigger emergency operation activities and demonstration that sufficient flood warning time exists for the completed operation of all closure structures, including necessary sealing, before floodwaters reach the base of the closure.

(ii) A formal plan of operation including specific actions and assignments of responsibility by individual name or title.

(iii) Provisions for periodic operation, at not less than one-year intervals, of the closure structure for testing and training purposes.

(2) *Interior drainage systems.* Interior drainage systems associated with levee systems usually include storage areas, gravity outlets, pumping stations, or a combination thereof. These drainage systems will be recognized by FEMA on NFIP maps for flood protection purposes only if the following minimum

criteria are included in the operation plan:

(i) Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials, that will be used to trigger emergency operation activities and demonstration that sufficient flood warning time exists to permit activation of mechanized portions of the drainage system.

(ii) A formal plan of operation including specific actions and assignments of responsibility by individual name or title.

(iii) Provision for manual backup for the activation of automatic systems.

(iv) Provisions for periodic inspection of interior drainage systems and periodic operation of any mechanized portions for testing and training purposes. No more than one year shall elapse between either the inspections or the operations.

(3) *Other operation plans and criteria.* Other operating plans and criteria may be required by FEMA to ensure that adequate protection is provided in specific situations. In such cases, sound emergency management practice will be the standard upon which FEMA determinations will be based.

(d) *Maintenance plans and criteria.* For levee systems to be recognized as providing protection from the base flood, the maintenance criteria must be as described herein. Levee systems must be maintained in accordance with an officially adopted maintenance plan, and a copy of this plan must be provided to FEMA by the owner of the levee system when recognition is being sought or when the plan for a previously recognized system is revised in any manner. All maintenance activities must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP that must assume ultimate responsibility for maintenance. This plan must document the formal procedure that ensures that the stability, height, and overall integrity of the levee and its associated structures and systems are maintained. At a minimum, maintenance plans shall specify the maintenance activities to be performed, the frequency of their performance, and the person by name or title responsible for their performance.

(e) *Certification requirements.* Data submitted to support that a given levee system complies with the structural requirements set forth in paragraphs (b)(1) through (7) of this section must be certified by a registered professional engineer. Also, certified as-built plans of the levee must be submitted. Certifications are subject to the definition given at §65.2 of this subchapter. In lieu of these structural requirements, a Federal agency with responsibility for levee design may certify that the levee has been adequately designed and constructed to provide protection against the base flood.

[51 FR 30316, Aug. 25, 1986]

### §65.11 Evaluation of sand dunes in mapping coastal flood hazard areas.

(a) *General conditions.* For purposes of the NFIP, FEMA will consider storm-induced dune erosion potential in its determination of coastal flood hazards and risk mapping efforts. The criterion to be used in the evaluation of dune erosion will apply to primary frontal dunes as defined in §59.1, but does not apply to artificially designed and constructed dunes that are not well-established with long-standing vegetative cover, such as the placement of sand materials in a dune-like formation.

(b) *Evaluation criterion.* Primary frontal dunes will not be considered as effective barriers to base flood storm surges and associated wave action where the cross-sectional area of the primary frontal dune, as measured perpendicular to the shoreline and above the 100-year stillwater flood elevation and seaward of the dune crest, is equal to, or less than, 540 square feet.

(c) *Exceptions.* Exceptions to the evaluation criterion may be granted where it can be demonstrated through authoritative historical documentation that the primary frontal dunes at a specific site withstood previous base flood storm surges and associated wave action.

[53 FR 16279, May 6, 1988]

# APPENDIX B

SITE VISIT PHOTOGRAPHS
AND
TAHQUITZ CREEK STATIONING EXHIBIT

Upstream end of levee at Station 0+00; looking downstream. Tahquitz Channel to the right.

From top of levee near Station 0+00, looking at Tahquitz Creek. Note: the channel is higher than top of levee.

Station 2+73, original concrete levee lining exposed.

Photo taken from top of levee at Station 5+51, looking upstream. Channel on left.

Photo taken from top of levee at Station 5+51, looking upstream. Levee landside slope on right.

Photo taken from top of levee at Station 7+83 looking at landside of levee. Ponding location at Demuth Park in the distance.

Wastewater treatment plant located on landside of levee near Station 17+13.

Station 25+97: erosion on channel slope of levee.

Station 25+97: Photo taken from top of levee looking upstream; channel on left.

Station 25+97: Photo taken from top of levee looking into the channel.

Station 25+97: Photo taken from top of levee looking into the channel.

Station 36+83: original concrete levee lining exposed.

End of levee at Highway 111, Station 40+90.

End of levee at Highway 111, Station 40+90.


GRAPHIC SCALE

0' 500' 1000' 1500' 2000'

SCALE: 1"= 500'

DATE: 6/25/09 TIME: 10:08:23 AM
SERVER: _____ LAYOUT: Layout1
PATH: N:\SDB050400\CADD\EXHIBITS
DRAWING NAME: TAHQUITZ CREEK EXHIBIT.DWG
PAGE SETUP: 11x17
DESIGNER: ENL PROJ. MGR: SCB

LOPEZE
XREFS: Palm Canyon Wash 2007, IMAGES: Google Earth Aerial View.jpg, Palm Canyon Wash USGS crop.JPG

NOLTE
BEYOND ENGINEERING
15070 AVENUE OF SCIENCE, SUITE 100 SAN DIEGO, CA 92128
858.385.0500 TEL. 858.385.0400 FAX WWW.NOLTE.COM

# TAHQUITZ CREEK LEVEE
## APPENDIX B

PREPARED FOR: THE CITY OF PALM SPRINGS

DATE SUBMITTED: 01/2009

SHEET NUMBER 1 OF 1 SHEETS

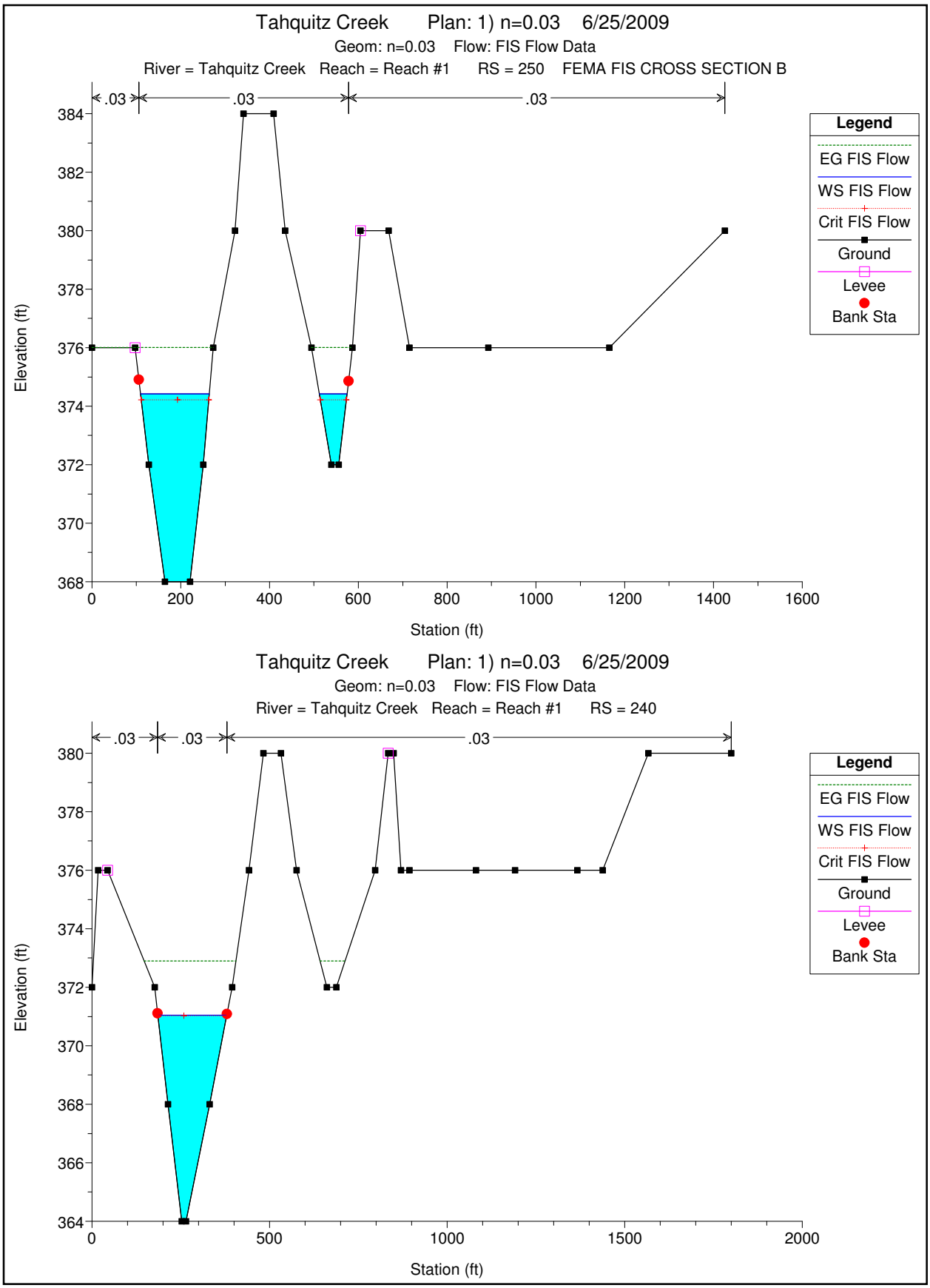
JOB NUMBER SDB050400

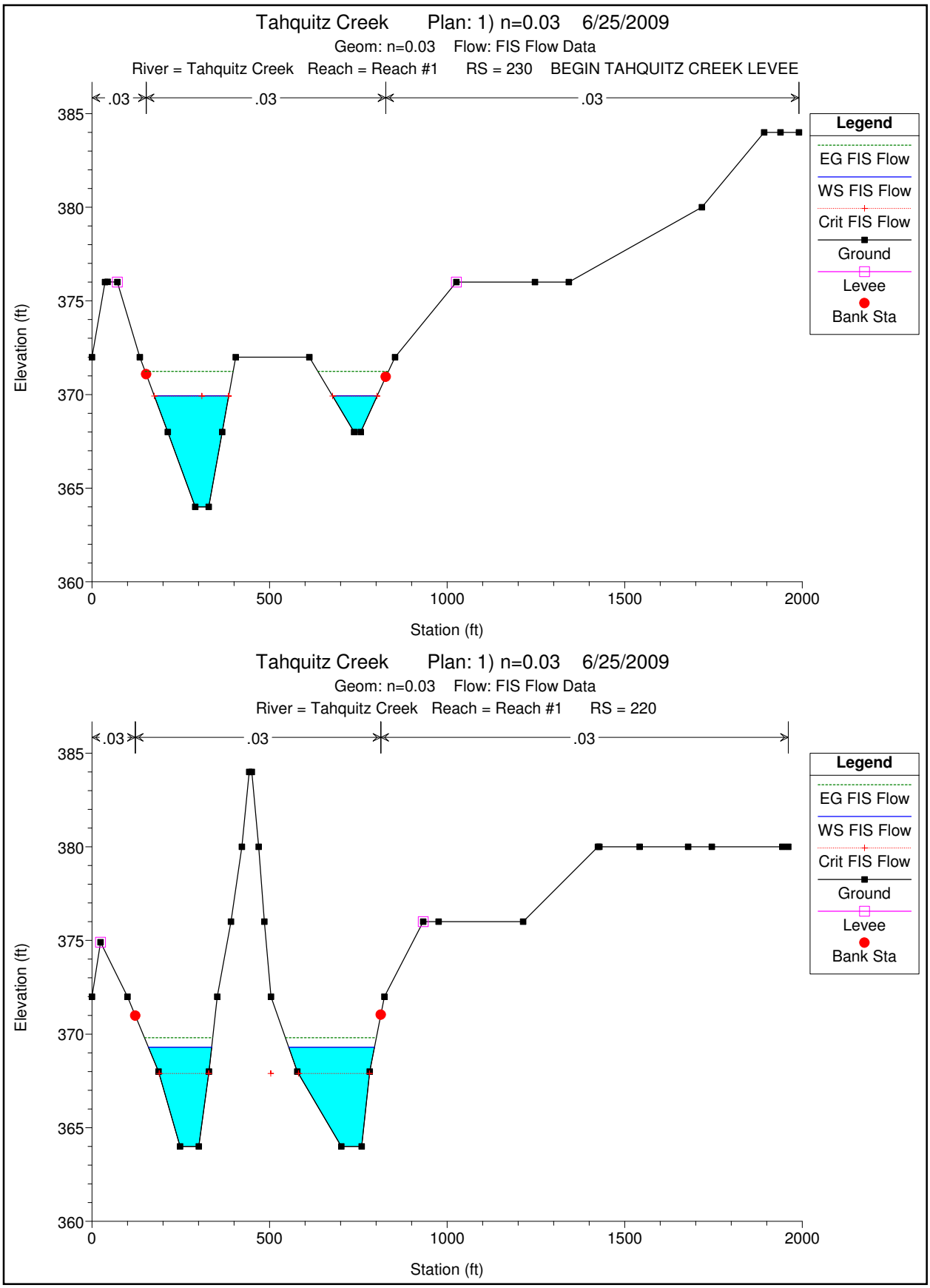
# APPENDIX C

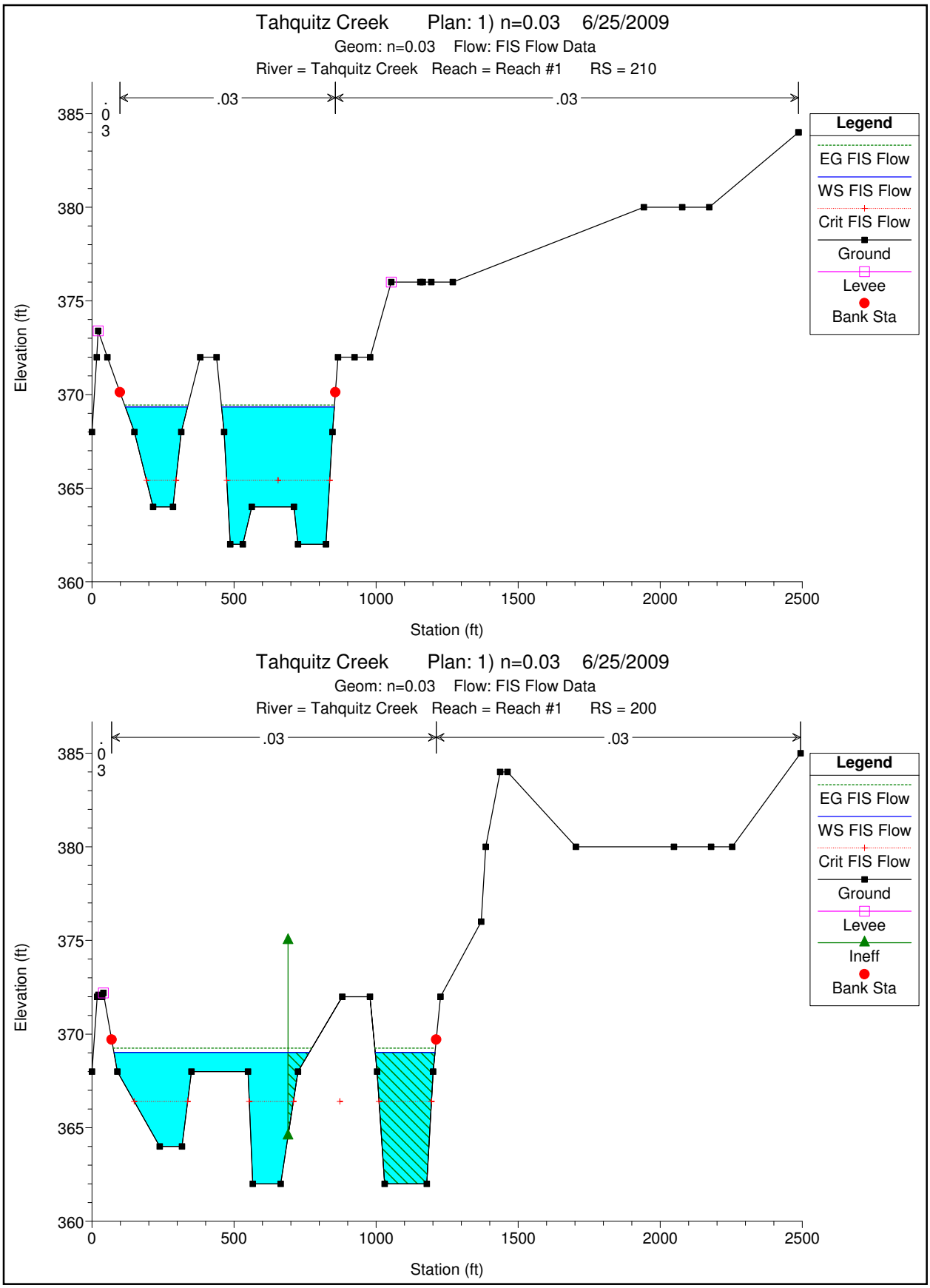
HEC-RAS WORKMAP AND HEC-RAS OUTPUT

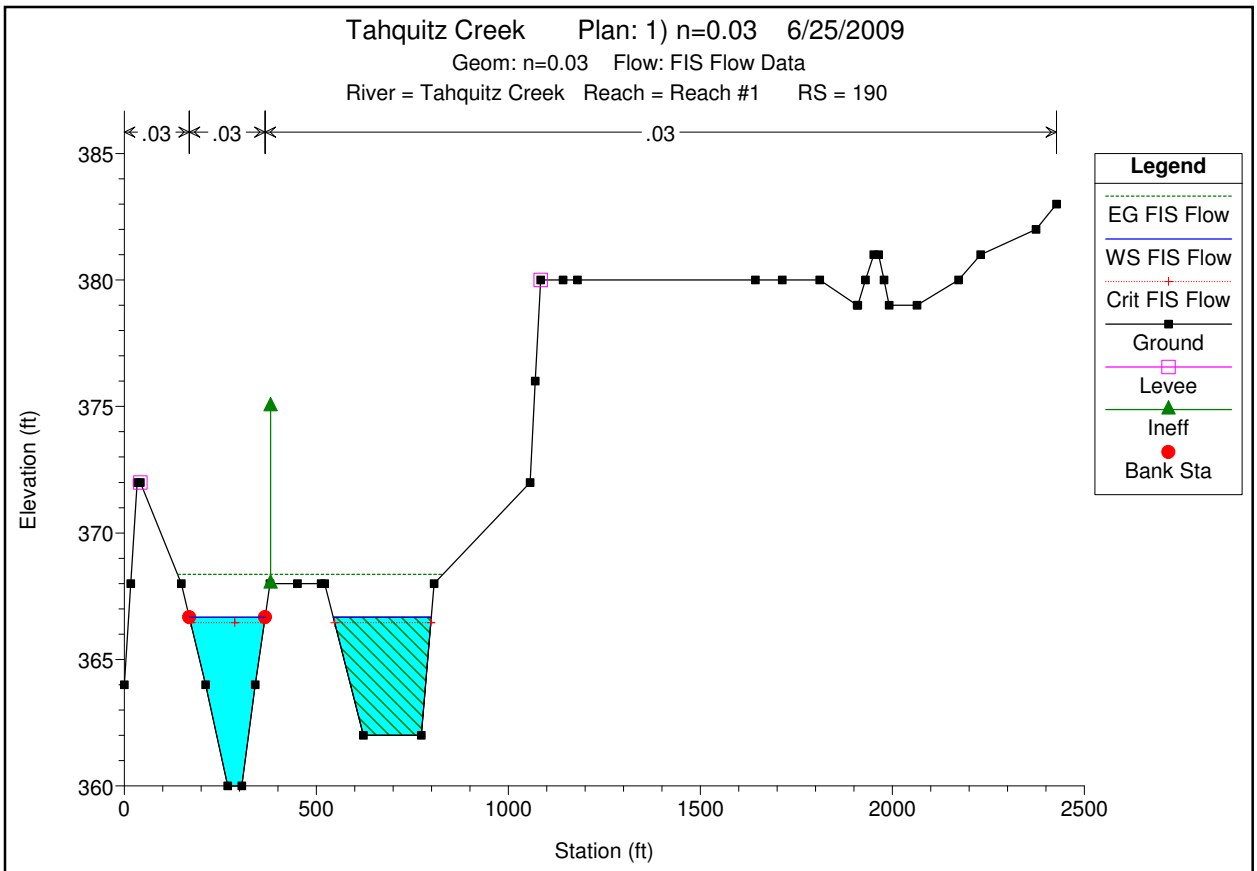
HEC-RAS Plan: n=0.03 River: Tahquitz Creek Reach: Reach #1 Profile: FIS Flow

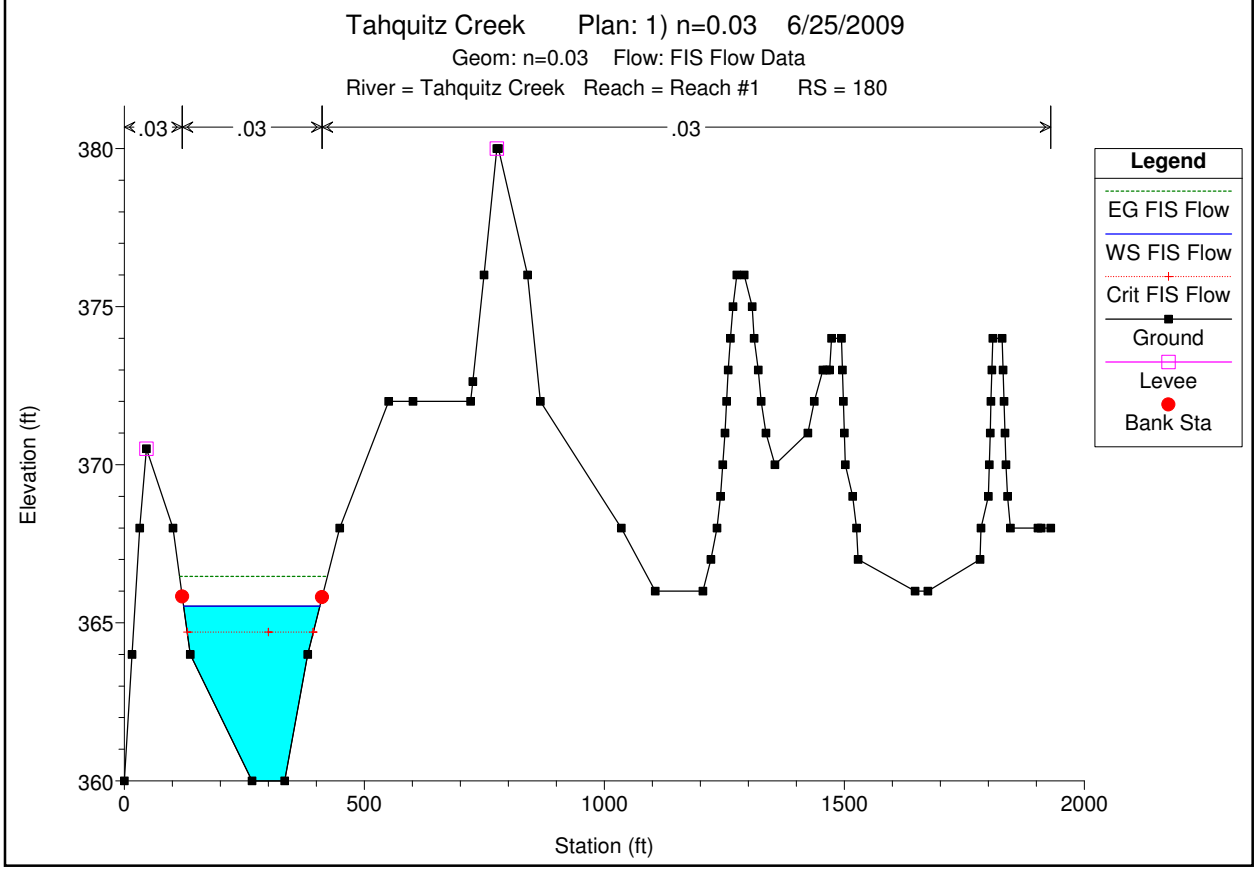
| Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Reach #1 | 250 | FIS Flow | 8000.00 | 368.00 | 374.42 | 374.22 | 376.01 | 0.007493 | 10.11 | 791.50 | 217.54 | 0.93 |
| Reach #1 | 240 | FIS Flow | 8000.00 | 364.00 | 371.05 | 371.02 | 372.90 | 0.008326 | 10.92 | 732.30 | 194.27 | 0.99 |
| Reach #1 | 230 | FIS Flow | 8000.00 | 364.00 | 369.93 | 369.92 | 371.24 | 0.009617 | 9.17 | 872.01 | 335.39 | 1.00 |
| Reach #1 | 220 | FIS Flow | 8000.00 | 364.00 | 369.30 | 367.89 | 369.80 | 0.002602 | 5.66 | 1412.60 | 419.83 | 0.54 |
| Reach #1 | 210 | FIS Flow | 8000.00 | 362.00 | 369.33 | 365.42 | 369.44 | 0.000330 | 2.61 | 3063.13 | 616.51 | 0.21 |
| Reach #1 | 200 | FIS Flow | 8000.00 | 362.00 | 369.02 | 366.40 | 369.25 | 0.001225 | 3.88 | 2060.32 | 897.84 | 0.37 |
| Reach #1 | 190 | FIS Flow | 8000.00 | 360.00 | 366.67 | 366.46 | 368.36 | 0.007265 | 10.43 | 767.34 | 452.43 | 0.93 |
| Reach #1 | 180 | FIS Flow | 8000.00 | 360.00 | 365.53 | 364.71 | 366.47 | 0.004441 | 7.78 | 1028.31 | 283.83 | 0.72 |
| Reach #1 | 170 | FIS Flow | 8000.00 | 356.00 | 363.83 | 363.17 | 364.91 | 0.005371 | 8.34 | 959.31 | 274.81 | 0.79 |
| Reach #1 | 160 | FIS Flow | 8000.00 | 354.00 | 362.92 | 361.34 | 363.57 | 0.003311 | 6.50 | 1233.12 | 368.34 | 0.62 |
| Reach #1 | 150 | FIS Flow | 8000.00 | 352.00 | 361.73 | 359.34 | 362.65 | 0.002536 | 7.69 | 1040.34 | 363.33 | 0.58 |
| Reach #1 | 140 | FIS Flow | 8000.00 | 352.00 | 361.18 | 359.25 | 361.60 | 0.002115 | 5.18 | 1544.42 | 454.87 | 0.49 |
| Reach #1 | 130 | FIS Flow | 8000.00 | 352.00 | 360.67 | 358.29 | 361.17 | 0.001665 | 5.64 | 1419.35 | 347.49 | 0.46 |
| Reach #1 | 120 | FIS Flow | 25200.00 | 350.00 | 357.30 | 357.30 | 359.19 | 0.008574 | 11.04 | 2282.82 | 608.18 | 1.00 |
| Reach #1 | 110 | FIS Flow | 25200.00 | 349.00 | 356.57 | 354.76 | 357.33 | 0.002114 | 7.04 | 3632.68 | 698.75 | 0.53 |
| Reach #1 | 100 | FIS Flow | 25200.00 | 348.00 | 355.28 | 353.84 | 356.46 | 0.003063 | 8.73 | 2896.60 | 517.49 | 0.64 |

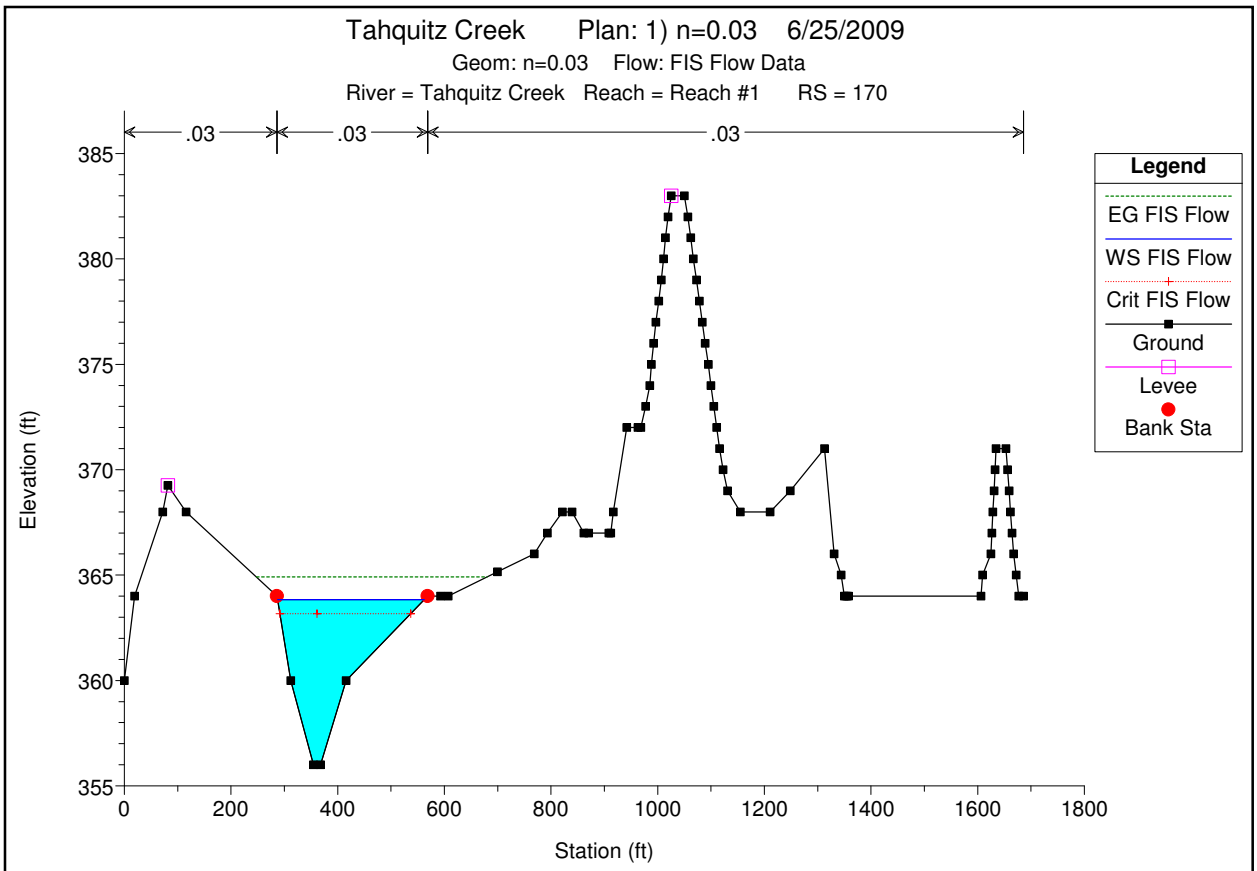

Tahquitz Creek Plan: 1) n=0.03 6/25/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 250 FEMA FIS CROSS SECTION B
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Bank Sta
Elevation (ft)
384
382
380
378
376
374
372
370
368
0
200
400
600
800
1000
1200
1400
1600
Station (ft)
Tahquitz Creek Plan: 1) n=0.03 6/25/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 240
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Bank Sta
Elevation (ft)
380
378
376
374
372
370
368
366
364
0
500
1000
1500
2000
Station (ft)

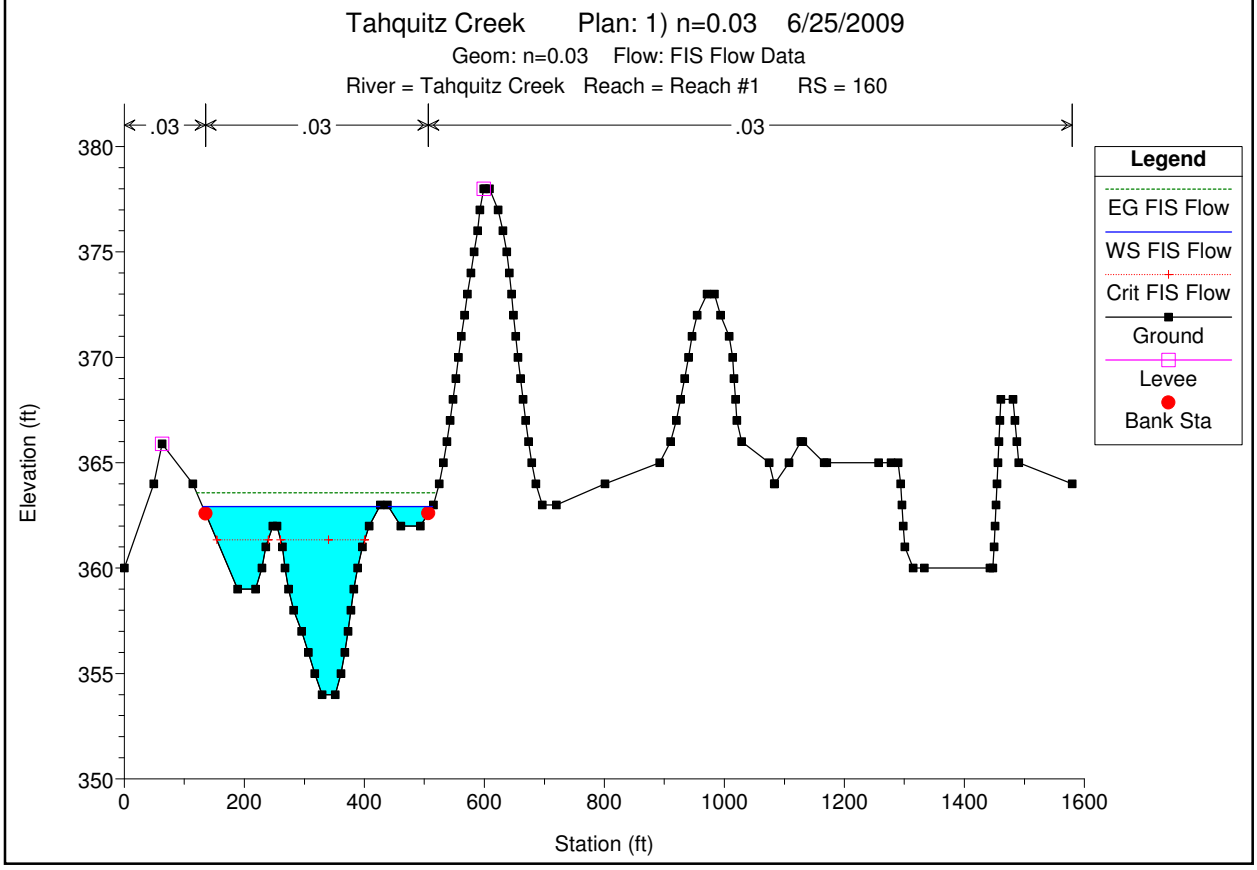

Tahquitz Creek Plan: 1) n=0.03 6/25/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 230 BEGIN TAHQUITZ CREEK LEVEE
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
Tahquitz Creek Plan: 1) n=0.03 6/25/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 220
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

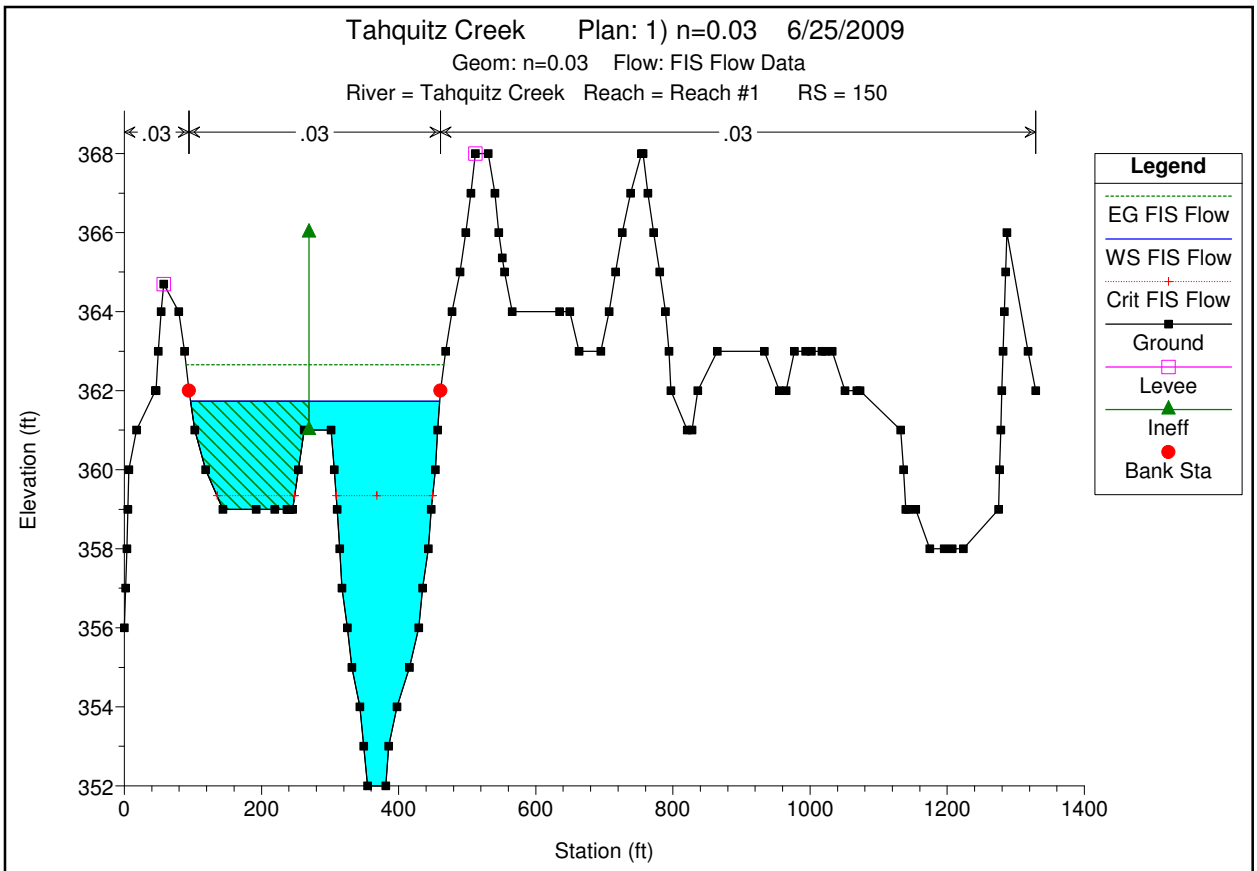

Tahquitz Creek Plan: 1) n=0.03 6/25/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 210
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
Tahquitz Creek Plan: 1) n=0.03 6/25/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 200
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

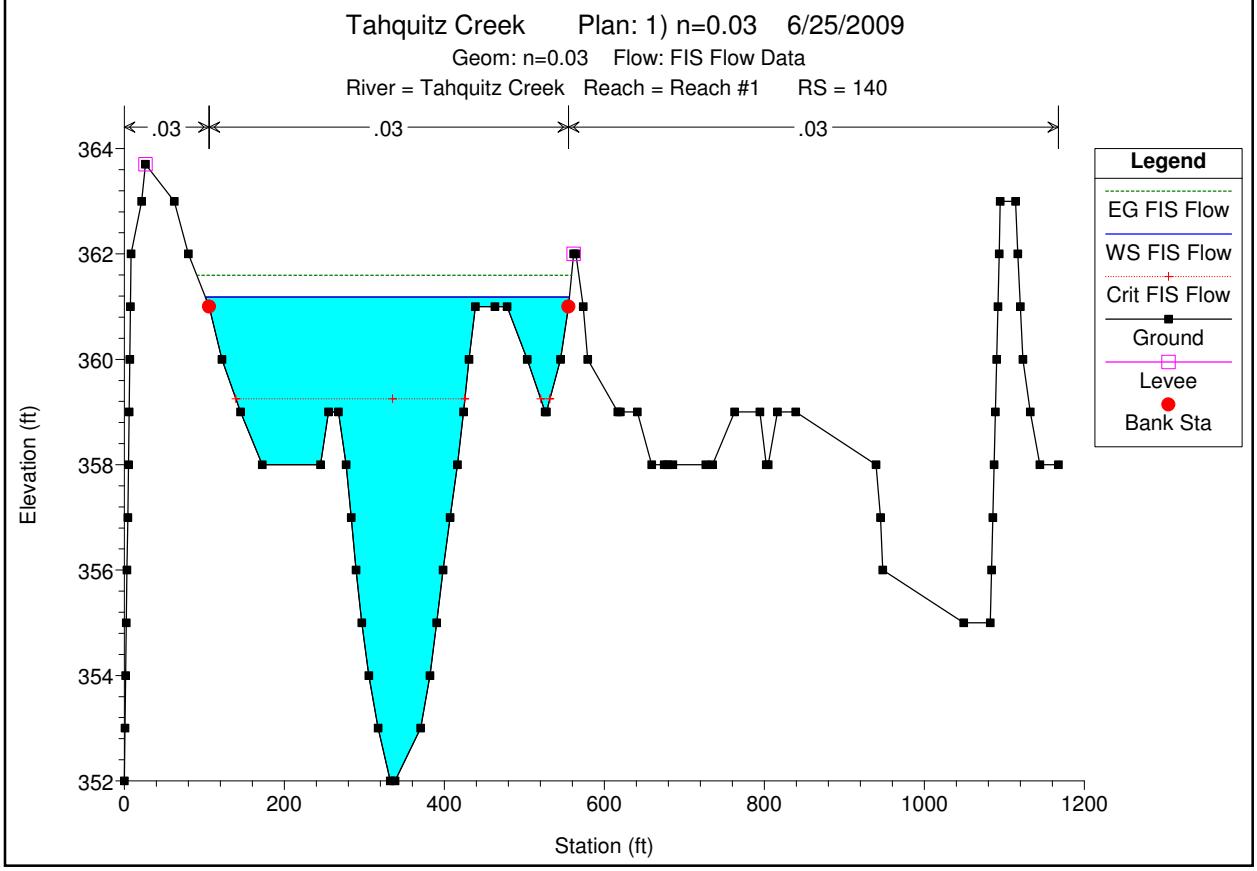

Tahquitz Creek Plan: 1) n=0.03 6/25/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 190
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
385
380
375
370
365
360
0
500
1000
1500
2000
2500
Station (ft)

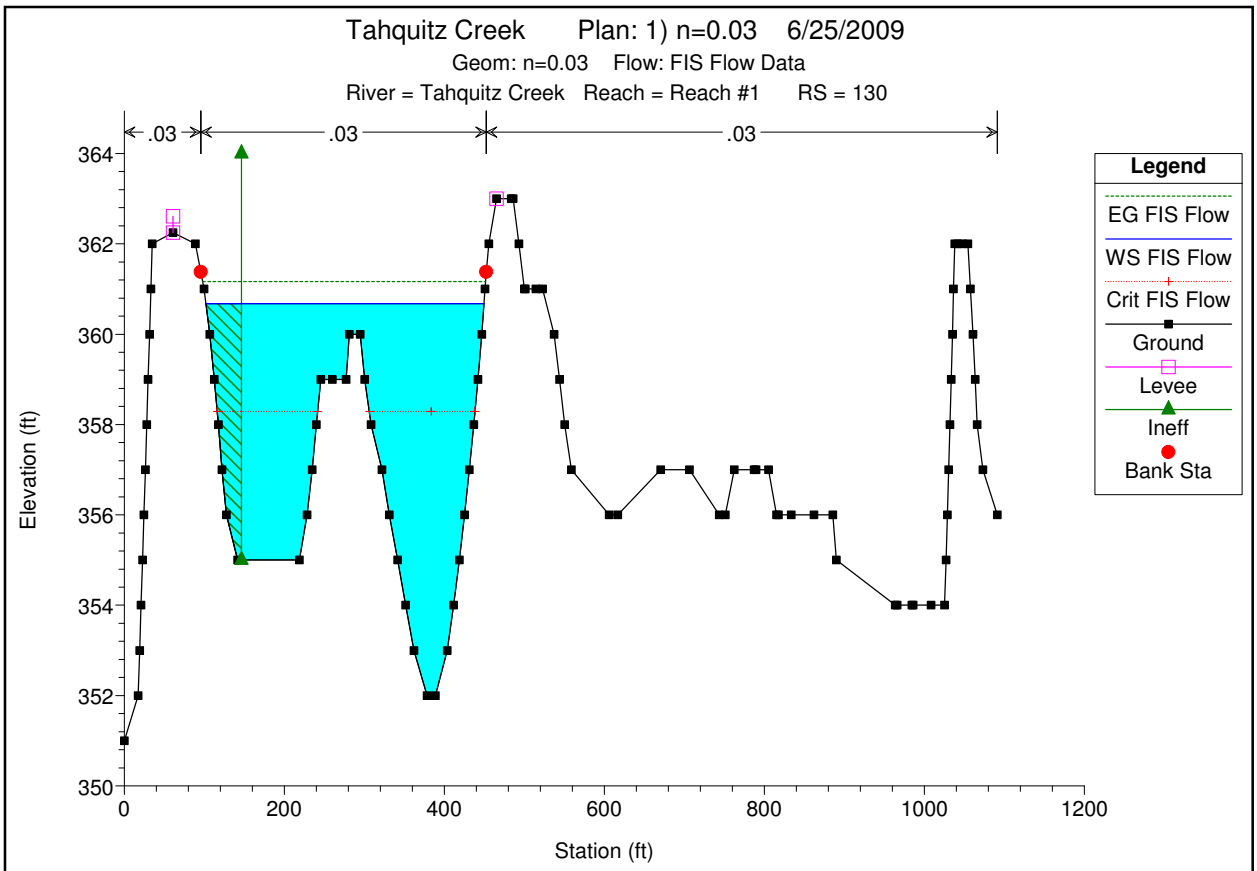

Tahquitz Creek Plan: 1) n=0.03 6/25/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 180
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Bank Sta
Elevation (ft)
380
375
370
365
360
0
500
1000
1500
2000
Station (ft)

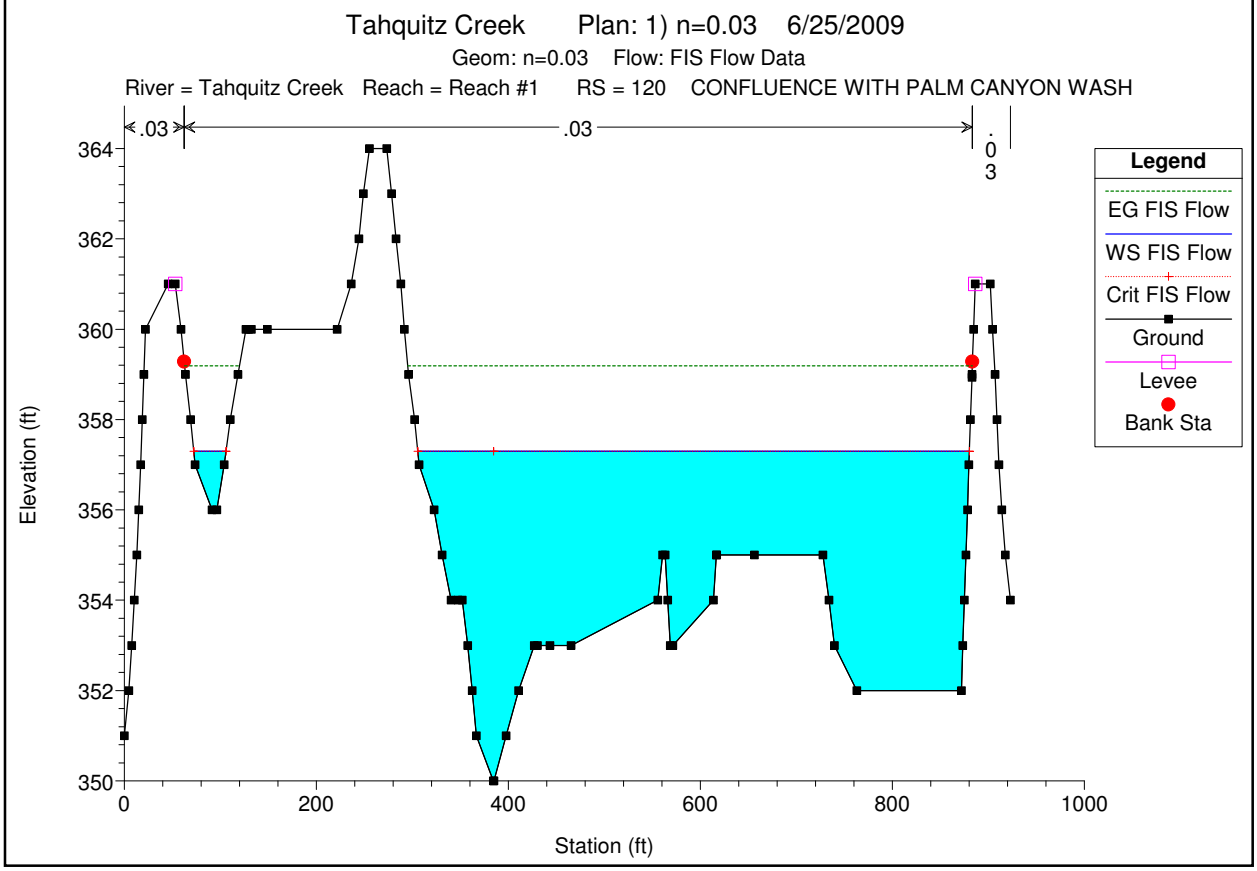

Tahquitz Creek Plan: 1) n=0.03 6/25/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 170
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

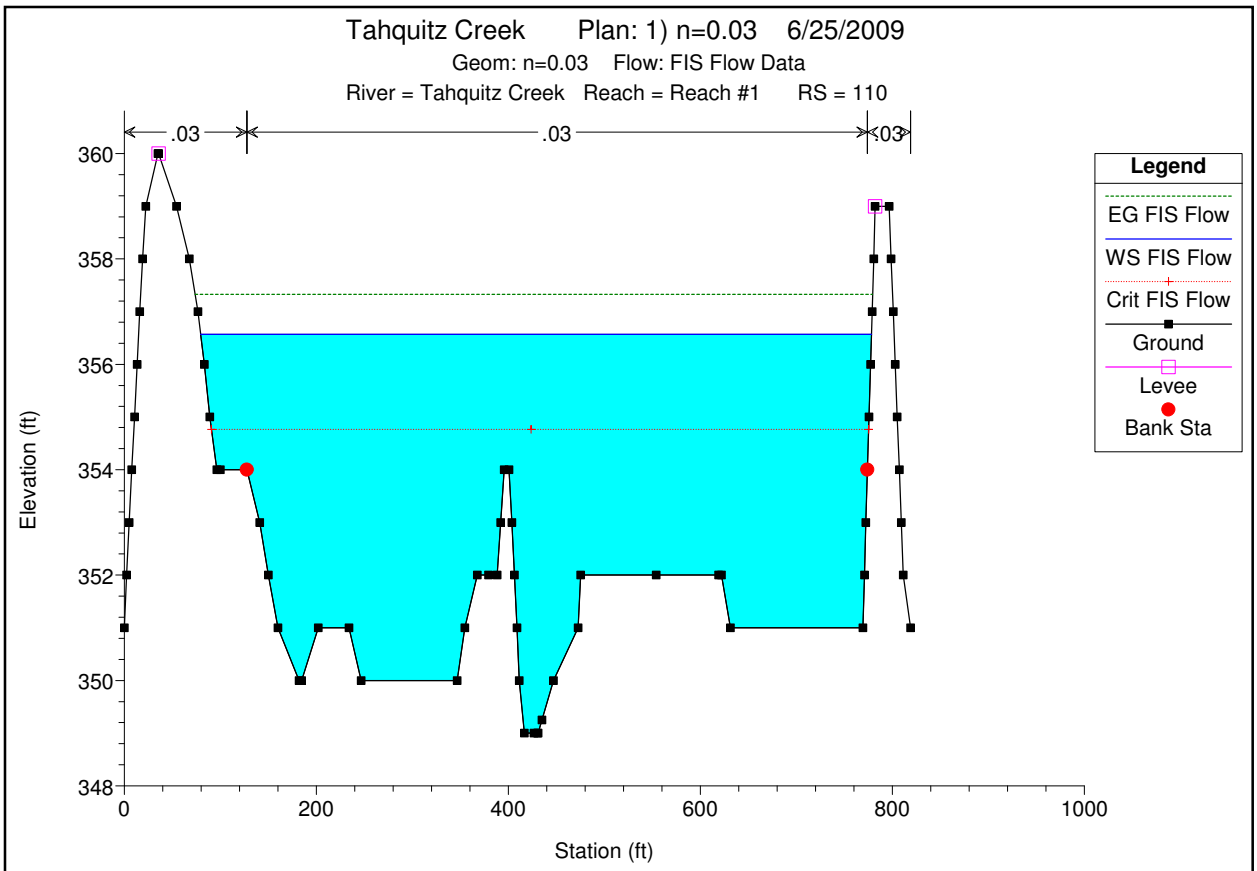

Tahquitz Creek Plan: 1) n=0.03 6/25/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 160
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

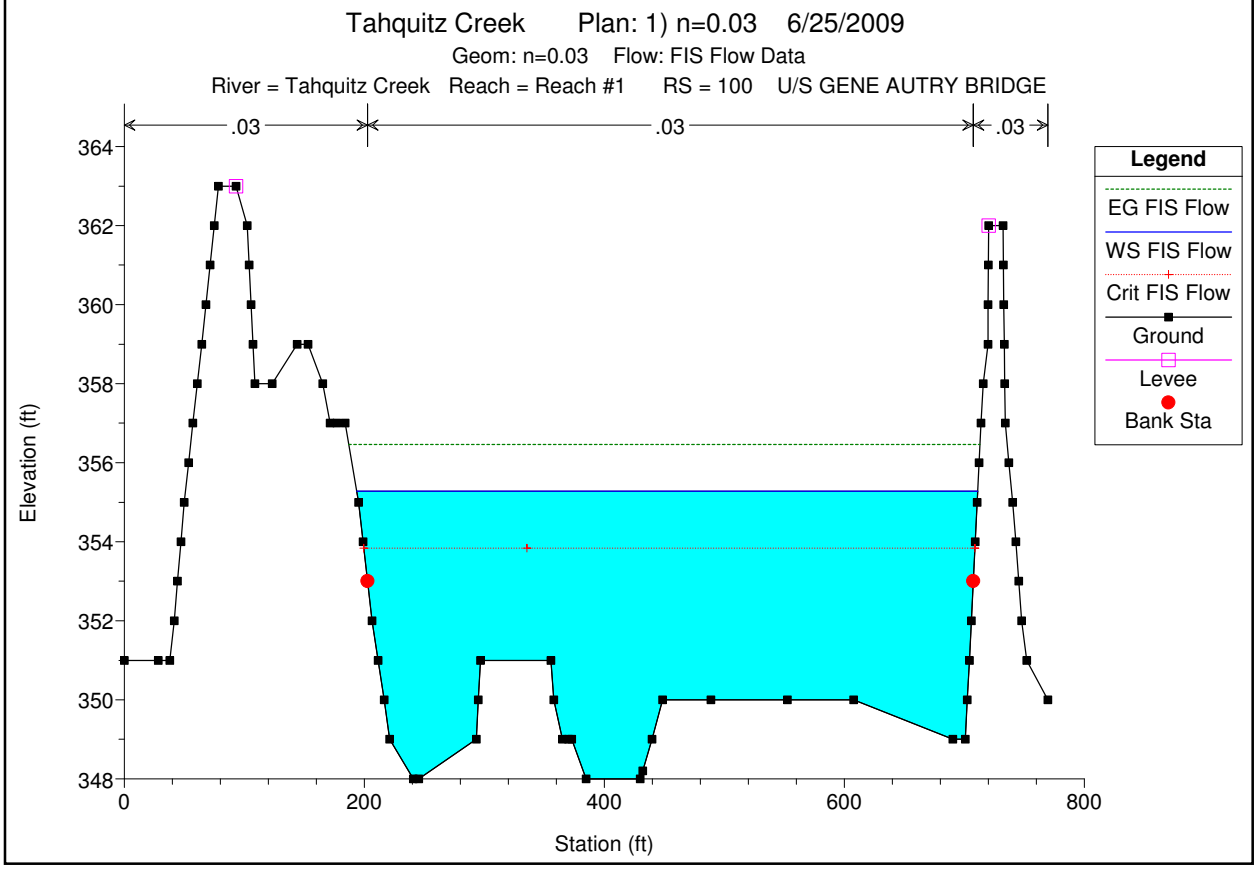

Tahquitz Creek Plan: 1) n=0.03 6/25/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 150
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
352
354
356
358
360
362
364
366
368
0
200
400
600
800
1000
1200
1400


Tahquitz Creek Plan: 1) n=0.03 6/25/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 140
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
352
354
356
358
360
362
364
0
200
400
600
800
1000
1200


Tahquitz Creek Plan: 1) n=0.03 6/25/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 130
.03
.03
.03
Elevation (ft)
Station (ft)
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Ineff
Bank Sta


Tahquitz Creek Plan: 1) n=0.03 6/25/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 120 CONFLUENCE WITH PALM CANYON WASH
.03
.03
Elevation (ft)
Station (ft)
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Bank Sta


Tahquitz Creek Plan: 1) n=0.03 6/25/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 110
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
360
358
356
354
352
350
348
0
200
400
600
800
1000


Tahquitz Creek Plan: 1) n=0.03 6/25/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 100 U/S GENE AUTRY BRIDGE
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
364
362
360
358
356
354
352
350
348
0
200
400
600
800


## LEGEND

- 100 — HEC-RAS CROSS-SECTION
- A — FEMA FLOOD INSURANCE STUDY CROSS SECTION
- 360 — 100-YEAR WATER SURFACE ELEVATION FROM NOLTE HEC-RAS MODEL
- AREAS THAT DO NOT MEET FREEBOARD REQUIREMENTS OF TITLE 44, CHAPTER 1 OF THE CODE OF FEDERAL REGULATIONS SECTION 65.10

DETAILED CONTOUR DATA (ONE-FOOT CONTOUR INTERVALS AND FOUR-FOOT CONTOUR INTERVALS), PROVIDED BY RIVERSIDE COUNTY FLOOD CONTROL & WATER CONSERVATION DISTRICT, HAS A VERTICAL DATUM OF NAVD88.

GRAPHIC SCALE
0' 200' 400' 600' 800'
SCALE: 1"= 200'

NOLTE BEYOND ENGINEERING

DATE: 8/7/09 TIME: 10:05:41 AM
SERVER: LAYOUT: HEC-RAS
PATH: N:\SDB050400\CADD\HH
DRAWING NAME: TAHQUITZ CREEK HEC-RAS EXHIBIT.DWG
PAGE SETUP: ----
DESIGNER: ENL PROJ. MGR: SCB

| NO. | BY | DATE | REVISIONS: |
|---|---|---|---|
| | | | |



NOLTE
BEYOND ENGINEERING
15070 AVENUE OF SCIENCE, SUITE 100 SAN DIEGO, CA 92128
858.385.0500 TEL 858.385.0400 FAX WWW.NOLTE.COM

# TAHQUITZ CREEK
## HEC-RAS WORKMAP

PREPARED FOR: THE CITY OF PALM SPRINGS DATE SUBMITTED: APRIL 2009

SHEET NUMBER 1 OF 1 SHEETS
SCALE VERTICAL: 1"= N/A HORIZONTAL: 1"= 200'
JOB NUMBER SDB050400

# APPENDIX D

FREEBOARD DEFICIENCY RECOMMENDATION EXHIBIT
AND
OPTION 1, 2, & 3 WSELs AND FREEBOARD SUMMARY

# Tahquitz Creek Levee Freeboard Evaluation
## Recommendations to Meet Freeboard Requirements

| FEMA Cross Section | NGVD29 CWSEL (ft) | [1]NAVD88 CWSEL (ft) | [2]Nolte HEC-RAS Cross Section | Existing Top of Levee (ft) | [2]Nolte WSEL (ft) | Freeboard (ft) | [2]Nolte WSEL (ft) | Freeboard (ft) | Proposed Top of Levee (ft) | [2]Nolte WSEL (ft) | Freeboard (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | [5] Option 1 | | [6] Option 2 | | [7] Option 3 | | |
| (B) | 372.4 | 375.1 | 250 | 376.0 | 374.42 | 1.58 | 374.42 | 1.58 | 376.0 | 374.42 | 1.58 |
| | | | 240 | 376.0 | 371.05 | 4.95 | 371.05 | 4.95 | 376.0 | 371.05 | 4.95 |
| | | | [3] 230 | 376.0 | 369.93 | 6.09 | 369.93 | 6.09 | 376.0 | 369.93 | 6.09 |
| | | | 220 | 374.9 | 369.30 | 5.60 | 369.30 | 5.60 | 374.9 | 369.30 | 5.60 |
| | | | 210 | 373.4 | 369.33 | 4.07 | 369.33 | 4.07 | 373.4 | 369.33 | 4.07 |
| (A) | 365.3 | 368.0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | 200 | 372.2 | 369.02 | 3.18 | 369.02 | 3.18 | 372.2 | 369.02 | 3.18 |
| | | | 190 | 372.0 | 366.67 | 5.33 | 366.67 | 5.33 | 372.0 | 366.67 | 5.33 |
| | | | 180 | 370.5 | 365.53 | 4.98 | 365.54 | 4.97 | 370.5 | 365.51 | 5.00 |
| | | | 170 | 369.3 | 363.82 | 5.44 | 363.79 | 5.47 | 369.3 | 363.92 | 5.34 |
| | | | 160 | 365.9 | 362.83 | 3.06 | 362.50 | 3.39 | 366.4 | 362.89 | 3.51 |
| | | | 150 | 364.7 | 361.44 | 3.26 | 361.46 | 3.24 | 365.2 | 361.74 | 3.46 |
| | | | 140 | 363.7 | 360.48 | 3.22 | 359.25 | 4.45 | 364.6 | 361.18 | 3.42 |
| (G) | 356.1 | 358.8 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | | | 130 | 362.3 | 358.67 | 3.58 | 359.11 | 3.14 | 364.2 | 360.68 | 3.52 |
| | | | [4] 120 | 361.0 | 357.29 | 3.71 | 357.46 | 3.54 | 361.0 | 357.30 | 3.70 |
| | | | 110 | 360.0 | 356.57 | 3.43 | 356.57 | 3.43 | 360.0 | 356.57 | 3.43 |
| | | | 100 | 363.0 | 355.28 | 7.72 | 355.28 | 7.72 | 363.0 | 355.28 | 7.72 |

**[1] NAVD88=NGVD29 + 2.7 ft**

**[2] Nolte water surface elevations have a vertical datum of NAVD88.**

**[3] Begin Tahquitz Creek Levee**

**[4] Confluence of Tahquitz Creek with Palm Canyon Wash**

**[5] Option 1: Grading of Palm Canyon Wash; XS's 130-110**

**[6] Option 2: Grading of Tahquitz Creek; XS's 120,130, & 150**

**[7] Option 3: Raise Tahquitz Creek Levee; XS's 130-160**


## LEGEND

- 100 — HEC–RAS CROSS–SECTION
- A — FEMA FLOOD INSURANCE STUDY CROSS SECTION
- AREAS THAT DO NOT MEET FREEBOARD REQUIREMENTS OF TITLE 44, CHAPTER 1 OF THE CODE OF FEDERAL REGULATIONS SECTION 65.10
- OPTION 1, GRADING OF PALM CANYON WASH: ANTICIPATED LIMITS OF GRADING
- OPTION 2, GRADING OF TAHQUITZ CREEK: ANTICIPATED LIMITS OF GRADING
- OPTION 3, INCREASE ELEVATION OF TAHQUITZ CREEK LEVEE: ANTICIPATED LIMITS OF GRADING

DETAILED CONTOUR DATA (ONE–FOOT CONTOUR INTERVALS AND FOUR–FOOT CONTOUR INTERVALS), PROVIDED BY RIVERSIDE COUNTY FLOOD CONTROL & WATER CONSERVATION DISTRICT, HAS A VERTICAL DATUM OF NAVD88.

GRAPHIC SCALE
0' 200' 400' 600' 800'
SCALE: 1"= 200'

DATE: 6/25/09 TIME: 1:30:54 PM
SERVER: LAYOUT: FREEBOARD
PATH: N:\SDB050400\CADD\HH
DRAWING NAME: TAHQUITZ CREEK HEC–RAS EXHIBIT.DWG
PAGE SETUP: ----
DESIGNER: ENL PROJ. MGR: SCB

| NO. | BY | DATE | REVISIONS: |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |



NOLTE
BEYOND ENGINEERING
15070 AVENUE OF SCIENCE, SUITE 100 SAN DIEGO, CA 92128
858.385.0500 TEL 858.385.0400 FAX WWW.NOLTE.COM

# TAHQUITZ CREEK
## FREEBOARD DEFICIENCY RECOMMENDATIONS EXHIBIT

PREPARED FOR: THE CITY OF PALM SPRINGS
DATE SUBMITTED: APRIL 2009

SHEET NUMBER 1 OF 1 SHEETS
SCALE
VERTICAL: 1"= N/A
HORIZONTAL: 1"= 200'
JOB NUMBER SDB050400

LOPEZ
V:\SDB\400_EXTD_FEILD_Palm Canyon Wash_Tahquitz Creek Topo_IMAGES_ s04c0519.tif, Palm Canyon Wash_USGS_crop.JPG

# APPENDIX E

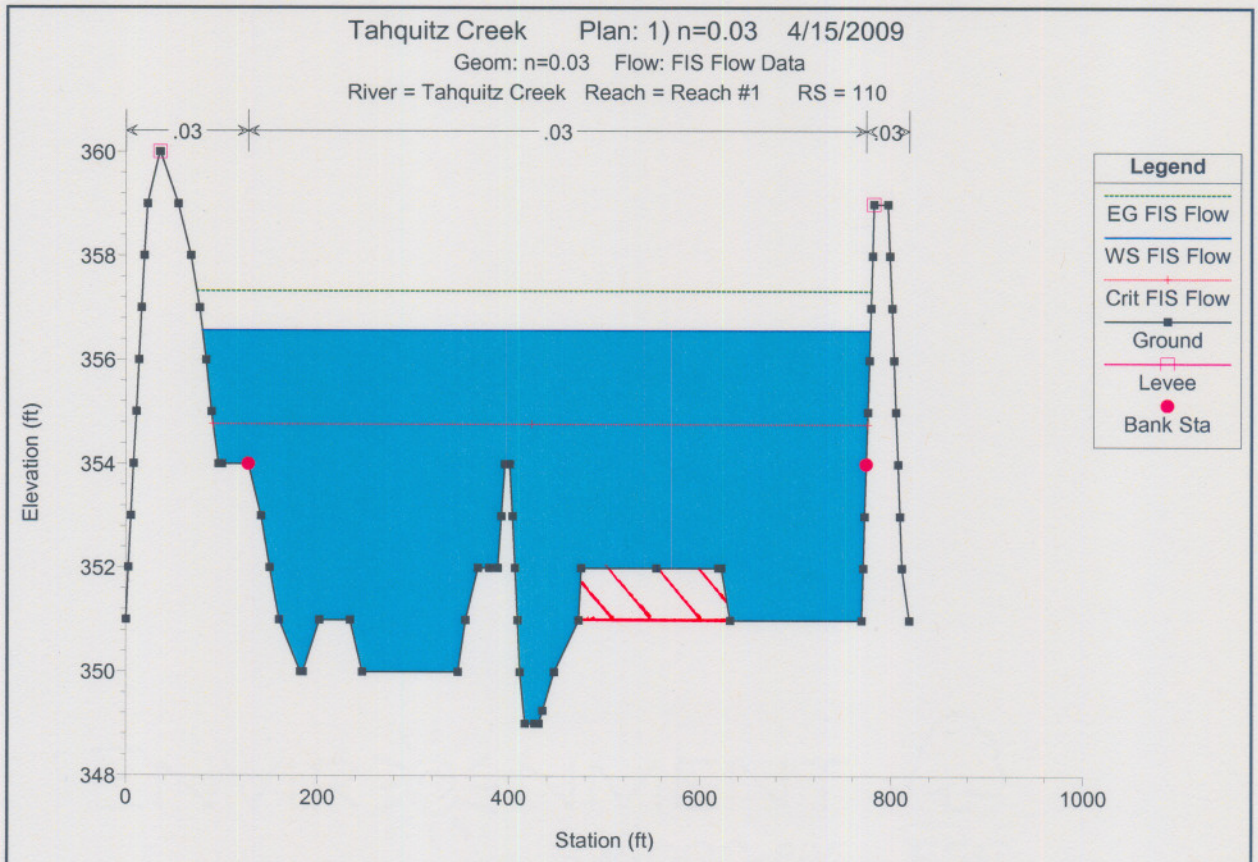
PALM CANYON WASH SUMMARY
AND
PROPOSED CROSS SECTIONS

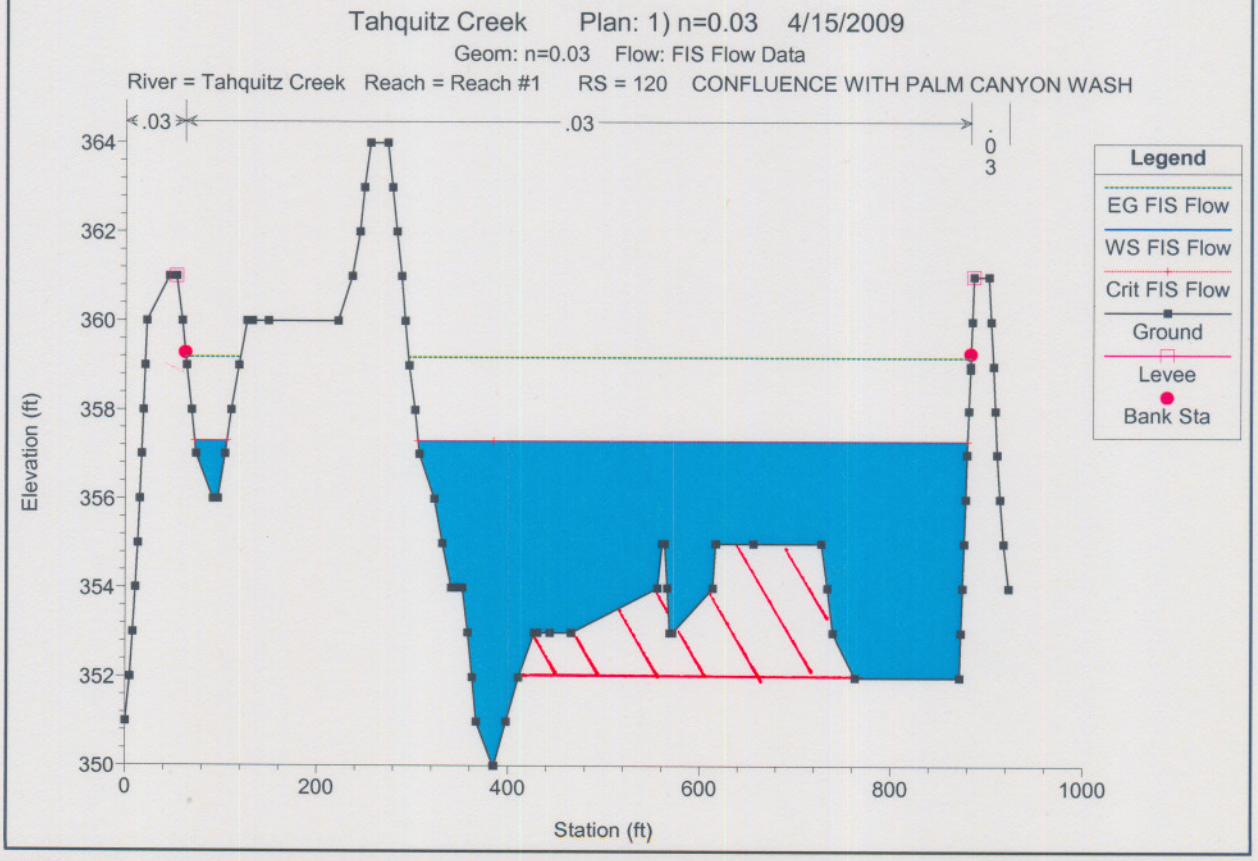
**Palm Canyon Wash**
**Option 1: Grade Palm Canyon Wash Near Confluence with Tahquitz Creek**
**Cross Sections and Results are from Palm Canyon Wash Nolte HEC-RAS Model**

| HEC - RAS XS | HEC - RAS WS Elev. (ft) | Proposed HEC-RAS WS Elev (ft) | Velocity (ft/s) | Proposed Velocity (ft/s) | 100-yr Q (cfs) | Right Top of Levee | Available Freeboard (ft) | Proposed Available Freeboard (ft) |
|---|---|---|---|---|---|---|---|---|
| 10 | 320.63 | 320.63 | 12.95 | 12.95 | 25200 | 332 | 11.37 | 11.37 |
| 20 | 323.13 | 323.13 | 13.99 | 13.99 | 25200 | 332 | 8.87 | 8.87 |
| 30 | 326.27 | 326.27 | 10.30 | 10.30 | 25200 | 335 | 8.73 | 8.73 |
| 40 | 327.38 | 327.38 | 9.56 | 9.56 | 25200 | 335.2 | 7.82 | 7.82 |
| 50 | 328.48 | 328.48 | 11.21 | 11.21 | 25200 | 336 | 7.52 | 7.52 |
| 60 | 329.11 | 329.11 | 15.02 | 15.02 | 25200 | 335.2 | 6.09 | 6.09 |
| 61 | 331.16 | 331.16 | 11.20 | 11.20 | 25200 | 335.5 | 4.34 | 4.34 |
| 66 | **Golf Club Drive Low Water Crossing** | | | | | | | |
| 70 | 334.29 | 334.29 | 10.85 | 10.85 | 25200 | 339.2 | 4.91 | 4.91 |
| 71 | 334.41 | 334.41 | 10.05 | 10.05 | 25200 | 339.5 | 5.09 | 5.09 |
| 80 | 336.51 | 336.51 | 12.95 | 12.95 | 25200 | 341.4 | 4.89 | 4.89 |
| 90 | 339.85 | 339.85 | 12.79 | 12.79 | 25200 | 343.7 | 3.85 | 3.85 |
| 100 | 342.60 | 342.60 | 12.00 | 12.00 | 25200 | 346.1 | 3.50 | 3.50 |
| 110 | 344.99 | 344.99 | 10.90 | 10.90 | 25200 | 348 | 3.01 | 3.01 |
| 120 | 346.49 | 346.49 | 12.96 | 12.96 | 25200 | 351.4 | 4.91 | 4.91 |
| 130 | 349.32 | 349.32 | 9.58 | 9.58 | 25200 | 352.8 | 3.48 | 3.48 |
| 140 | 350.22 | 350.22 | 10.13 | 10.13 | 25200 | 354.8 | 4.58 | 4.58 |
| 150 | 351.04 | 351.04 | 13.29 | 13.29 | 25200 | 356.8 | 5.76 | 5.76 |
| 160 | 354.75 | 354.75 | 9.30 | 9.30 | 25200 | 357.9 | 3.15 | 3.15 |
| 170 | 356.07 | 356.07 | 5.99 | 5.99 | 25200 | 363 | 6.93 | 6.93 |
| 175 | **Gene Autry Bridge** | | | | | | | |
| 180 | 356.50 | 356.50 | 5.79 | 5.79 | 25200 | 362 | 5.50 | 5.50 |
| 190 | 356.93 | 356.93 | 8.32 | 7.05 | 25200 | 360 | 3.07 | 3.07 |
| 200 | 358.17 | 357.81 | 12.43 | 9.31 | 25200 | 362.3 | 4.13 | 4.49 |
| 210 | 363.08 | 363.08 | 13.14 | 13.14 | 23200 | 364.3 | 1.22 | 1.22 |
| 220 | 367.98 | 367.98 | 13.52 | 13.52 | 23200 | 368.7 | 0.72 | 0.72 |
| 230 | 369.07 | 369.07 | 13.42 | 13.42 | 23200 | 370.9 | 1.83 | 1.83 |
| 240 | 373.20 | 373.20 | 13.50 | 13.50 | 23200 | 374.8 | 1.60 | 1.60 |
| 250 | 378.63 | 378.63 | 13.68 | 13.68 | 23200 | 381.4 | 2.77 | 2.77 |
| 260 | 383.35 | 383.35 | 13.56 | 13.56 | 23200 | 385.7 | 2.35 | 2.35 |
| 270 | 389.08 | 389.08 | 13.51 | 13.51 | 23200 | 390.8 | 1.72 | 1.72 |
| 280 | 395.07 | 395.07 | 13.52 | 13.52 | 23200 | 396.7 | 1.63 | 1.63 |
| 290 | 397.74 | 397.74 | 13.48 | 13.48 | 23200 | 399.3 | 1.56 | 1.56 |
| 300 | 402.31 | 402.31 | 13.67 | 13.67 | 23200 | 406.8 | 4.49 | 4.49 |
| 301 | **East Palm Canyon Drive Bike Crossing** | | | | | | | |
| 302 | 403.93 | 403.93 | 11.26 | 11.25 | 23200 | 407 | 3.07 | 3.07 |
| 303 | 403.88 | 403.89 | 11.85 | 11.84 | 23200 | 407 | 3.12 | 3.11 |
| 304 | 403.91 | 403.91 | 12.18 | 12.17 | 23200 | 408 | 4.09 | 4.09 |
| 306 | **East Palm Canyon Drive Bridge** | | | | | | | |
| 309 | 406.00 | 405.92 | 10.11 | 10.23 | 23200 | 408 | 2.00 | 2.08 |
| 315 | 409.30 | 409.30 | 12.36 | 12.36 | 23200 | not a levee | | |
| 320 | 412.36 | 412.36 | 12.83 | 12.83 | 23200 | not a levee | | |
| 330 | 419.31 | 419.31 | 11.97 | 11.97 | 23200 | not a levee | | |
| 340 | 425.65 | 425.65 | 11.69 | 11.68 | 23200 | not a levee | | |
| 350 | 433.51 | 433.51 | 12.55 | 12.55 | 23200 | not a levee | | |
| 360 | 441.12 | 441.12 | 12.77 | 12.77 | 23200 | not a levee | | |
| 370 | 447.44 | 447.44 | 11.96 | 11.96 | 23200 | not a levee | | |
| 380 | 455.29 | 455.28 | 12.27 | 12.28 | 23200 | not a levee | | |
| 390 | 462.35 | 462.35 | 13.61 | 13.61 | 23200 | not a levee | | |
| 400 | 469.14 | 469.14 | 12.24 | 12.24 | 23200 | not a levee | | |
| 410 | 475.49 | 475.49 | 11.55 | 11.55 | 23200 | not a levee | | |
| 420 | 483.45 | 483.45 | 12.14 | 12.14 | 23200 | not a levee | | |
| 430 | 493.97 | 493.97 | 12.19 | 12.17 | 23200 | not a levee | | |
| 440 | 499.18 | 499.16 | 7.66 | 7.73 | 2900 | not a levee | | |
| 445 | 502.41 | 502.41 | 8.21 | 8.21 | 2900 | not a levee - golf course | | |
| 450 | 503.73 | 503.73 | 7.11 | 7.11 | 2900 | not a levee - golf course | | |
| 455 | 506.90 | 506.91 | 7.24 | 7.21 | 2900 | not a levee - golf course | | |
| 460 | 508.25 | 508.24 | 4.97 | 4.97 | 2900 | not a levee - golf course | | |
| 470 | 514.24 | 514.24 | 7.35 | 7.35 | 2900 | not a levee - golf course | | |
| 480 | 517.62 | 517.62 | 7.14 | 7.14 | 2900 | not a levee - golf course | | |
| 485 | 521.25 | 521.25 | 9.12 | 9.12 | 2900 | not a levee - golf course | | |
| 490 | 522.20 | 522.20 | 2.94 | 2.94 | 2900 | not a levee - golf course | | |
| 495 | 523.06 | 523.06 | 10.81 | 10.81 | 2900 | not a levee - golf course | | |
| 500 | 524.91 | 524.91 | 1.75 | 1.75 | 2900 | not a levee - golf course | | |
| 510 | 524.90 | 524.90 | 3.55 | 3.55 | 2900 | not a levee - golf course | | |
| 520 | 525.20 | 525.20 | 2.59 | 2.59 | 2900 | not a levee - golf course | | |
| 530 | 525.34 | 525.34 | 2.80 | 2.80 | 2900 | not a levee - golf course | | |
| 540 | 525.52 | 525.52 | 2.45 | 2.45 | 2900 | not a levee - golf course | | |
| 550 | 526.14 | 526.14 | 9.24 | 9.24 | 2900 | not a levee - golf course | | |
| 555 | 527.69 | 527.69 | 4.61 | 4.61 | 2900 | not a levee - golf course | | |
| 560 | 529.42 | 529.42 | 10.75 | 10.74 | 2900 | not a levee - golf course | | |
| 570 | 531.68 | 531.68 | 0.72 | 0.72 | 330 | not a levee - golf course | | |
| 575 | 531.68 | 531.68 | 0.82 | 0.82 | 330 | not a levee - golf course | | |
| 580 | 531.67 | 531.67 | 1.64 | 1.64 | 330 | not a levee - golf course | | |
| 590 | 531.67 | 531.67 | 1.75 | 1.75 | 330 | not a levee - golf course | | |
| 595 | **South Palm Canyon Drive Bridge** | | | | | | | |
| 600 | 531.73 | 531.73 | 3.97 | 3.97 | 330 | not a levee | | |
| 601 | 532.99 | 532.99 | 6.26 | 6.26 | 330 | not a levee | | |
| 602 | 533.48 | 533.48 | 3.66 | 3.66 | 330 | not a levee | | |
| 603 | 533.47 | 533.47 | 4.86 | 4.86 | 330 | not a levee | | |
| 610 | 533.66 | 533.66 | 5.89 | 5.89 | 330 | not a levee | | |
| 620 | 535.78 | 535.78 | 7.88 | 7.88 | 330 | not a levee | | |
| 630 | 545.88 | 545.88 | 8.11 | 8.11 | 330 | not a levee | | |
| 640 | 563.56 | 563.56 | 8.06 | 8.06 | 330 | not a levee | | |
| 650 | 575.48 | 575.48 | 7.81 | 7.81 | 330 | not a levee | | |
| 660 | 579.16 | 579.16 | 7.40 | 7.40 | 330 | not a levee | | |
| 670 | 583.01 | 583.01 | 7.35 | 7.35 | 330 | not a levee | | |
| 680 | 589.21 | 589.21 | 7.65 | 7.65 | 330 | not a levee | | |
| 690 | 594.90 | 594.90 | 7.38 | 7.38 | 330 | not a levee | | |
| 700 | 601.94 | 601.94 | 5.72 | 5.72 | 330 | not a levee | | |

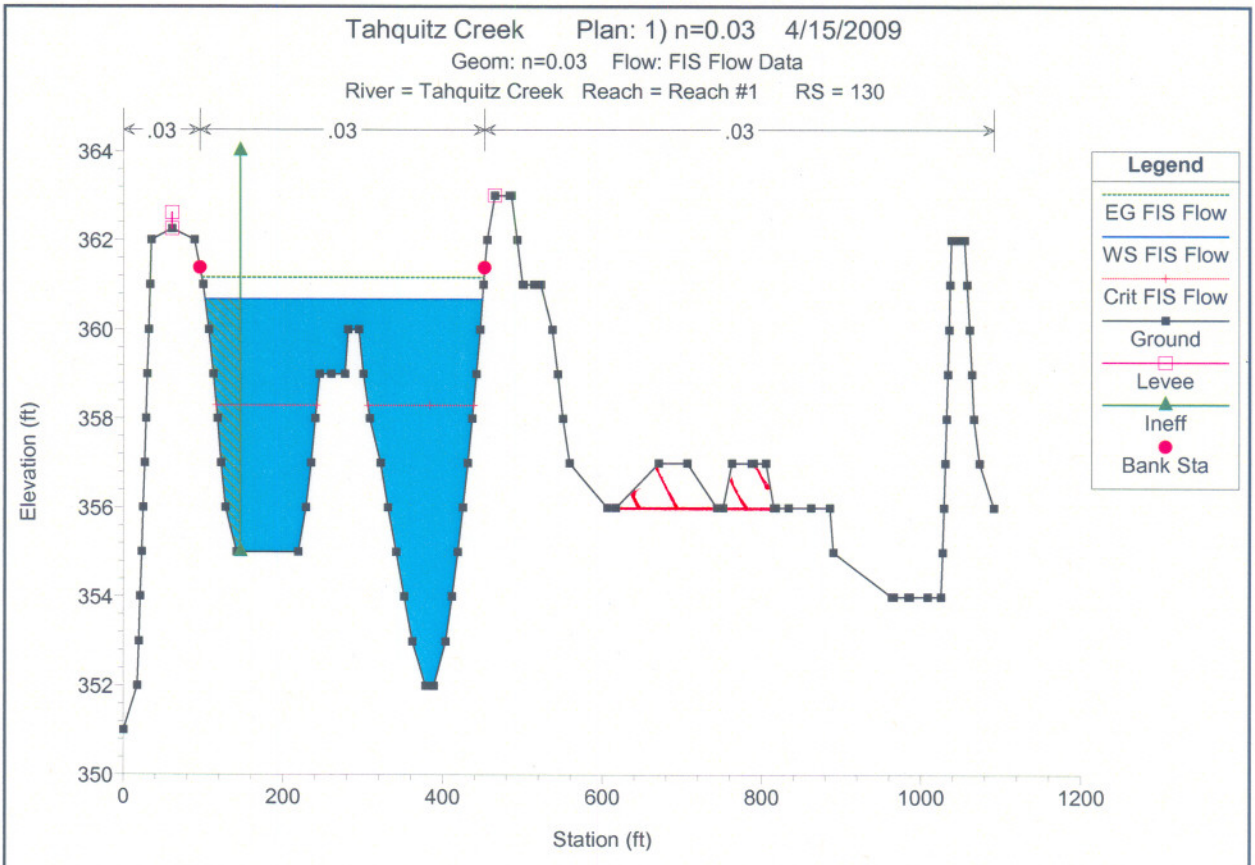
Does not meet Section 65.10 freeboard requirement

Changes caused by grading of Palm Canyon Wash



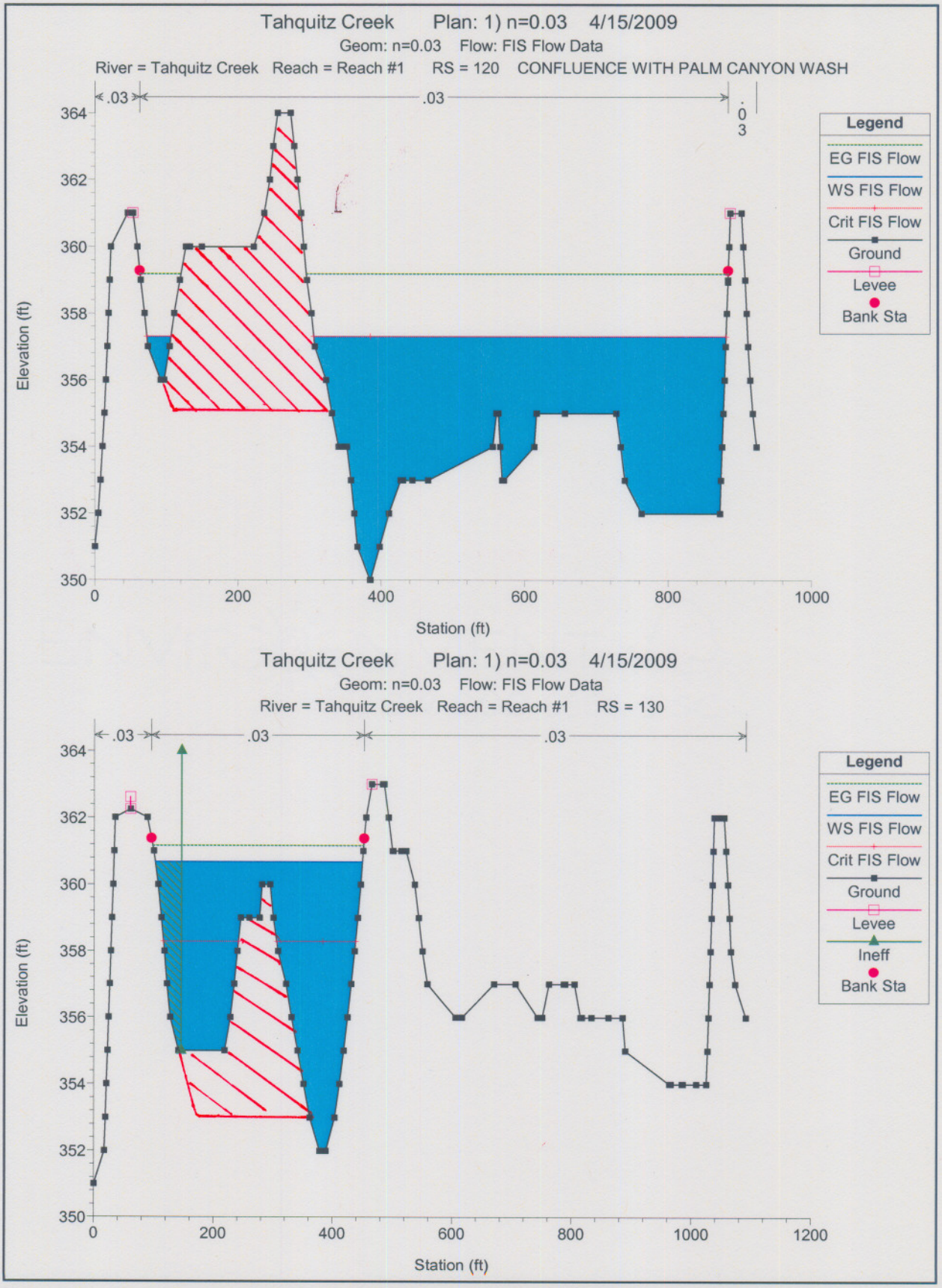




AREA TO BE REMOVED

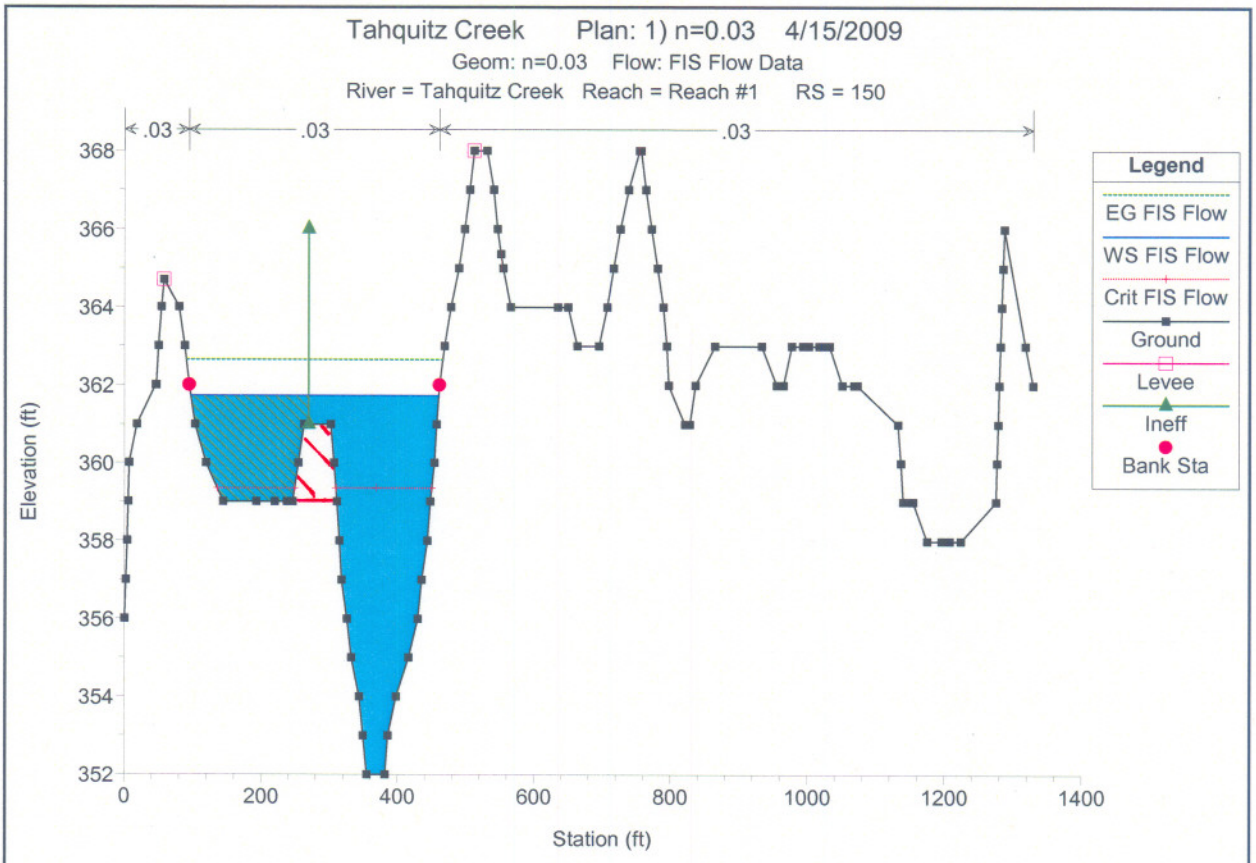

Tahquitz Creek Plan: 1) n=0.03 4/15/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 130
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
364
362
360
358
356
354
352
350
0
200
400
600
800
1000
1200
Station (ft)

# APPENDIX F

OPTION 2: PROPOSED CROSS SECTIONS

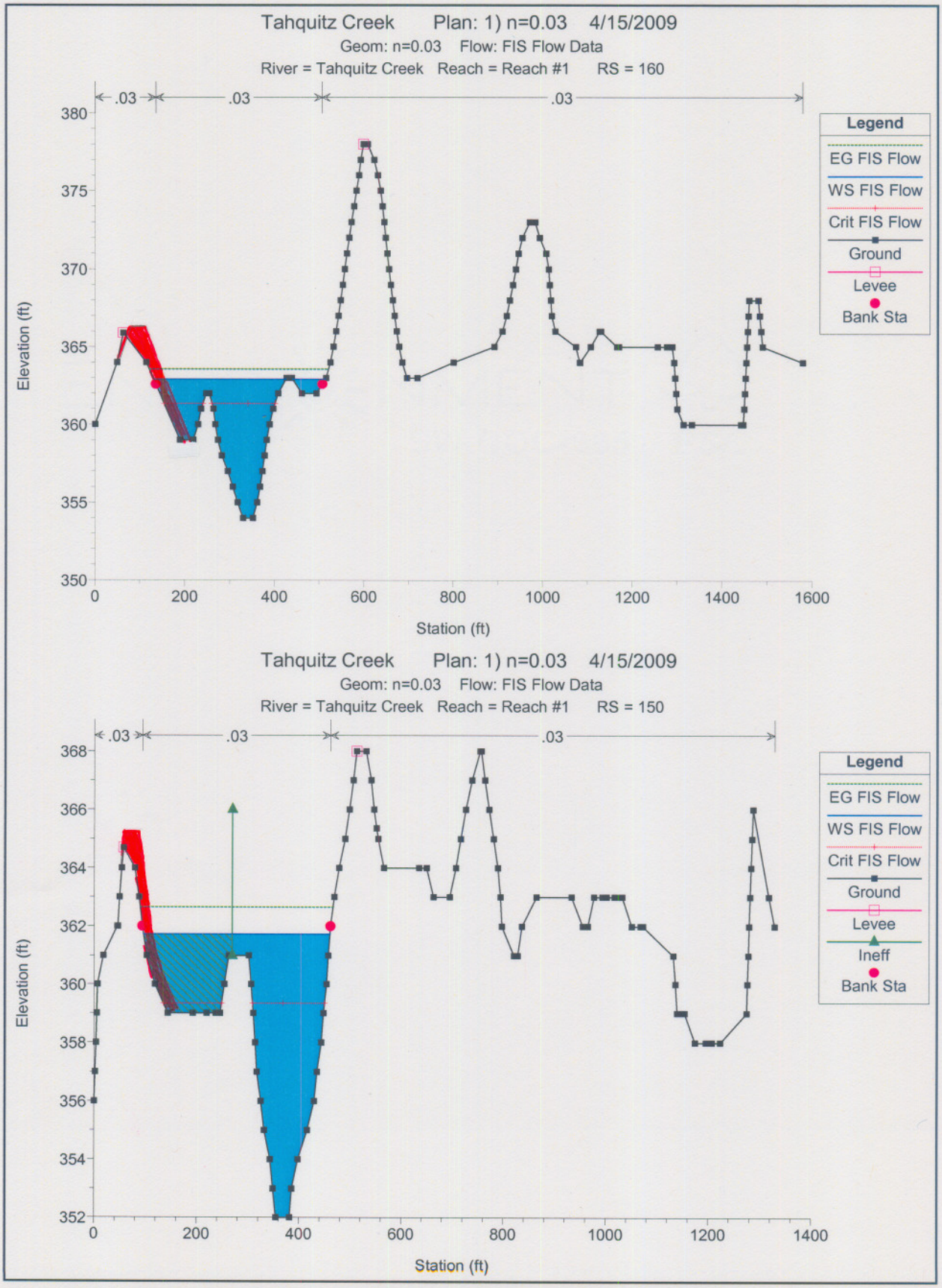



AREA TO BE REMOVED

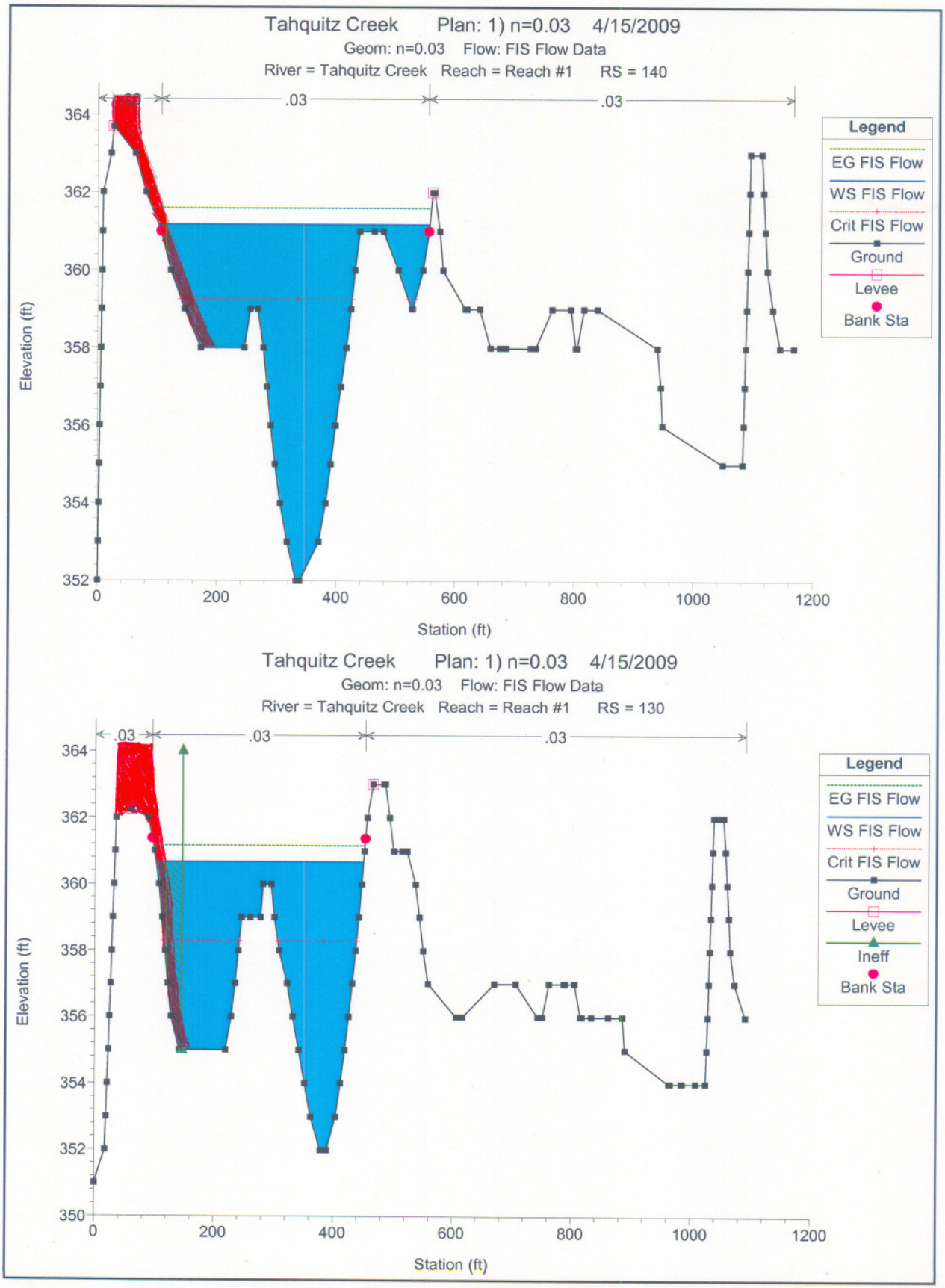

Tahquitz Creek Plan: 1) n=0.03 4/15/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 150
.03
.03
.03
Elevation (ft)
368
366
364
362
360
358
356
354
352
0
200
400
600
800
1000
1200
1400
Station (ft)
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Ineff
Bank Sta

# APPENDIX G

OPTION 3: PROPOSED CROSS SECTIONS




APPROXIMATE CHANGE OF LEVEE TO INCREASE TOP OF LEVEE


Tahquitz Creek Plan: 1) n=0.03 4/15/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 140
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Bank Sta
Elevation (ft)
364
362
360
358
356
354
352
0
200
400
600
800
1000
1200
Station (ft)
Tahquitz Creek Plan: 1) n=0.03 4/15/2009
Geom: n=0.03 Flow: FIS Flow Data
River = Tahquitz Creek Reach = Reach #1 RS = 130
.03
.03
.03
Legend
EG FIS Flow
WS FIS Flow
Crit FIS Flow
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
364
362
360
358
356
354
352
350
0
200
400
600
800
1000
1200
Station (ft)

# APPENDIX H

TAHQUITZ CREEK OPERATIONS AND MAINTENANCE PLAN

**FLOOD CONTROL LEVEE INSPECTION, MONITORING, AND MAINTENANCE MANUAL**
**Tahquitz Creek**
**Palm Springs, California**

## 1.0 PURPOSE

This document describes the City of Palm Spring's (City) operation and maintenance procedures for City facilities consisting of levee embankments. This manual is intended to provide a basic framework for inspecting, monitoring, and maintaining the levee. The procedures will be modified, as necessary, to reflect conditions and experience gained during the inspection process.

The Operations and Maintenance (O&M) Division of the City is charged with the operation and maintenance of all City facilities. The O&M Superintendent is directly responsible for the continuing inspection, operation and maintenance of these facilities. To accomplish this, the O&M Superintendent directs a staff of equipment operators, maintenance workers and their supervisors. The O&M Superintendent is responsible for training and directing their personnel so that routine maintenance is performed effectively, and to ensure that problems are detected in the early stage and appropriate corrective measures taken.

In the case of facilities constructed for the City by the U. S. Army Corps of Engineers, the City is required to submit a semi-annual report to them. Projects constructed through programs of the U. S. Soil Conservation Service, and owned and operated by the City, are inspected jointly on an annual basis.

Use and alteration of City facilities by others is controlled by an encroachment permit process within the O&M Division. The Permit section is headed by a Civil Engineer. Encroachment permits for all connections to City facilities, and/or use of City property, are issued only if the proposed use will not have an adverse effect, and is compatible with the facilities' intended function.

## 2.0 LEVEE DESCRIPTION

This manual provides operation and maintenance guidelines for the following levee reach:

- The levee is located on the north side of Tahquitz Creek from Tahquitz Creek Golf Course (adjacent to Demuth Park) to Gene Autry Trail. The upstream limit of the levee begins at approximately 4,090 feet northwest of Gene Autry Trail to Gene Autry Trail (downstream limit).

**Tahquitz Creek** (Excerpts from Tahquitz Creek and Palm Canyon Channel, Vicinity of the Tahquitz Canyon Golf Course within the City of Palm Springs, Maintenance Plan, prepared by John M. Tettemer and Associates, Inc., November 1999).

In 1994, the City of Palm Springs constructed an expansion of the existing City Municipal Golf Course, now referred to as the Tahquitz Canyon Golf Course. The golf course expansion was constructed within a FEMA mapped flood plain as shown on Flood Insurance Rate Map (FIRM) Panel Numbers 060257 0006B, 0008B, and 0009B. The area of Tahquitz Creek affected by the golf course expansion project is generally located in the area of the confluence with Palm Canyon Wash Channel, between El Cielo Road and the Gene Autry Trail Bridge. Within this confluence area, the flood protection facilities consist of the north levee, a series of streambed stabilization structures, and miscellaneous erosion control improvements.

The north levee was constructed originally as a flood control dike consisting of compacted earth fill and concrete slope protection on the creek side. As a part of the golf course construction, fill was placed against the concrete slope protection and shaped in accordance with the golf course grading plan. This levee was shown on the FIRMs prior to construction of the golf course.

A total of eight stabilization structures were constructed in Tahquitz Creek within the golf course. Four of the structures were constructed of ungrouted riprap materials. These structures were buried with their crests set approximately one foot beneath the creek flowline. The remaining four stabilization structures consist of concrete cart crossings with buried riprap

upstream and downstream of the crossing structures. A portion of the downstream riprap is grouted in place. The crossing structures are each provided with the low-flow culverts passing beneath the concrete cart path.

The miscellaneous erosion control improvements include ungrouted riprap slope protection in Tahquitz Creek between the El Cielo cart path crossing and the next downstream stabilizer structure, and both grouted and ungrouted riprap within the last 900 lineal feet of the creek prior to the confluence with Palm Canyon Channel. Both grouted and ungrouted riprap slope protection was constructed on the southerly slope of the golf course immediately adjacent to Palm Canyon Channel, and erosion control mat material was placed on the slopes adjacent to Tahquitz Creek and Palm Canyon Channel.

## 3.0 INSPECTION AND MONITORING PROGRAM

To keep the levee in good condition, a program of inspections will be undertaken at regular intervals to observe the condition of the levee embankments. In addition to the regularly scheduled inspections, the levee system will be inspected after any unusual occurrence, such as an earthquake, or severe storm. The purpose of these inspections is to detect conditions that might adversely affect the performance of the levee. Quick response to the development of potentially adverse conditions will keep the levee in good condition and performing as designed and constructed.

Inspections of the levee system will be made by qualified persons who are familiar with the design, construction, and maintenance of small dams and levees. Personnel from the City can be trained to perform inspections of the levee. The publication "Dam Safety: An Owner's Guidance Manual" prepared by the Federal Emergency Management Agency (August 1987) can be used to train personnel for levee inspections. The inspection reports will be reviewed by a registered civil engineer of the State of California.

Since an important aspect of the inspection program is assessing changes that occur over time, it is important that a continuity of inspection personnel be maintained. In addition, the records of each inspection should be accurate and complete so that a thorough and complete record of conditions observed during previous inspections is available.

# 4.0 INSPECTIONS

## 4.1 SCHEDULE

Regular inspections of the levee embankment will be made at minimum of six month intervals (twice a year). Known trouble areas are visited more frequently. In addition to the regularly scheduled inspections, a complete inspection will also be made after an earthquake or severe storm. Earthquakes that generate ground motions that are felt by most people inside buildings are a threshold event that will initiate an inspection. During periods of flooding, all levees are patrolled throughout the event. City engineering and technical personnel are assigned to these patrols to supplement the maintenance personnel during these emergency periods.

## 4.2 PREPARATION FOR INSPECTION

Before making a regular inspection, the inspector will review this manual and the previous inspection reports so that he or she is thoroughly familiar with any previously noted unusual or abnormal conditions and is aware of the remedial measures that have been taken to correct any adverse conditions.

## 4.3 INSPECTION PROCEDURES

Open Channels (Including Soft Bottom and Leveed Channels) - It is the City's policy, within the original design parameters, to keep open channels free of vegetation, debris and miscellaneous materials that tend to collect in them. This must be accomplished in a manner in compliance with the related environmental rules as administered by the resource agencies (State Department of Fish and Game - 1601 Agreements, State Water Resources Control Board - 401 Permits, and the Army Corps of Engineers - 404 Permits). Maintenance roads are kept weed-free, and rodent and erosion damage is repaired. Vegetation in soft bottom channels is kept to a height that will not impede or divert flows toward channel side-slopes or levee embankments. Any structural damage, i.e., cracked concrete, settling, warping of invert or channel sides is repaired as necessary. Subdrain systems are checked for proper functioning. Security fencing is kept repaired.

Levees - Levees are kept free of uncontrolled growth and drift deposits. Erosion and rodent damage is repaired. Rodent populations are controlled by an on-going program of poisoning or trapping. Hardened slope facing is kept repaired and/or replaced as necessary. Drainage structures through levees are kept in good working condition (outlets are kept free of debris and any riprap is maintained to prevent undermining). The levees are surveyed annually, and after seismic activity, to determine if any settlement or other movement has occurred. Any movement is reviewed to determine if remedial work is needed.

## 4.4 INSPECTION RECORDS

A record of each inspection of the levee embankment and structural wall will be made and filed with the O&M Superintendent who has overall responsibility for maintaining the levee system. Conditions that appear to adversely affect the performance of the levee and require corrective work will be brought to O&M Superintendent's attention immediately. Areas requiring routine maintenance work will also be brought to the O&M Superintendent's attention. The inspection form included in this manual or similar inspection record form will be completed for each inspection. Photographs will be taken during the levee inspection, and each photograph dated and described. Plan drawings showing the extent of seepage, unusual settlement, and other conditions that may be significant to the performance and safety of the levee will be prepared and filed with the inspection report. Videos also may be useful to document unusual or abnormal conditions.

# 5.0 MAINTENANCE

## 5.1 GENERAL

Periodic work and maintenance will be required to maintain the levee embankment in good condition. Occasional maintenance and repair work may be needed to control seepage, repair slope erosion areas, and fill in cracks or holes in the embankment.

The timing and need for maintenance work will be based on results of the inspection and settlement survey records. The type and extent of needed repair work will be documented on the inspection record. It is important that the inspection and survey records be thorough and accurate and that they be reviewed by persons responsible for maintenance of the levee.

## 5.2 LEVEE EMBANKMENT SLOPES

The primary concerns regarding the slopes are erosion, stability, and seepage. Eroded areas will be repaired. Erosion is generally the result of concentrating surface water flow at one location. In this case, measures such as adjusting grades along the levee crest can be taken to more evenly distribute the overland flow. After surface drainage has been improved, the eroded areas, if more than 6 inches deep, will be backfilled with compacted fill. Golf course turf covers the concrete slope protection in many areas of the north levee. In the event that the concrete slope protection is undermined, cracked or settled, the effective concrete slabs will be repaired or replaced. Sloughs, slides, or subsidence are indicative of instability and will be carefully evaluated and repaired immediately. Repair may consist of excavation, re-compaction, and installation of drainage measures. Specific repair measures will be developed by the O&M Superintendent or experienced civil or geotechnical engineer.

Seepage along the toe of the inboard slope may occur after prolonged flood conditions. This condition can be handled by installing subdrains or ditches, to direct the water into the existing storm sewer system.

## 5.3 LEVEE EMBANKMENT CREST

The levee embankment is expected to settle less than 0.5 inches over its design life. Sources of fill material needed to raise the levee crest, if necessary, will be identified and reserved for this use or fill material will be stockpiled onsite for this purpose.

## 5.4 STREAMBED STABILIZATION STRUCTURES & MISCELLANEOUS EROSION CONTROL IMPROVEMENTS

A. Buried Ungrouted Riprap Stabilizers

Where riprap stabilizer structures are exposed due to flood flows, displaced, or undermined, riprap shall be repositioned or replaced to the original design crest elevations.

B. Cart Path Stabilizer Structures

Where ungrouted riprap has been exposed due to flood flows, displaced, or undermined, riprap shall be repositioned or replaced to the original design grades. Where grouted riprap on the downstream side of the structures has been undermined, settled, or cracked, cracks and voids will be repaired by placing additional riprap and grouting to fill avoids.

C. Ungrouted Riprap Toe Protection

Riprap used for slope toe protection along the creek or along the southerly limits of the golf course west of the Gene Autry Trail Bridge, which has been displaced due to storm events, will be repositioned or replaced to the original design grades.

D. Erosion Mat Material

Erosion mat material placed adjacent to or as a part of riprap erosion protection which has been displaced or lost due to flood flow shall be repositioned or replaced. Plant materials washed out with the erosion mat due to flood flows shall also be replaced.